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A Compendium of Available Bicycle and Pedestrian Trip Generation Data in the United States

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A Supplement to the National Bicycling and Walking Study

A Compendium of Available Bicycle and Pedestrian Trip Generation Data in the United States

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CHAPTER 1. INTRODUCTION AND METHOD

Background

The purpose of this project was to gather information to aid in the determination of trip generation rates for various bicycling and walking facilities, such as signed and marked bicycle lanes, wide curb lanes, multi-use paths, and sidewalks. To put it more simply, if a pedestrian or bicycle facility is built, how many people will use it? In the current climate of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), States, metropolitan planning organizations (MPOs), and localities have more flexibility to plan for and implement bicyclist and pedestrian facilities and related programs. Planners, engineers, researchers, and bicycling/walking advocates thus all have a great need for information related to the use of bicycling and walking facilities. This project, performed as a supplemental activity to the National Bicycling and Walking Study, was an attempt to provide such information.

Trip Generation as It Relates to Motor Vehicles, Bicycles, and Pedestrians

Trip generation estimation is important to a broad range of short- and long-term urban planning and traffic engineering activities. For example, public officials need to know whether existing transportation facilities can adequately meet the additional travel demand generated by a new office tower or residential subdivision. If not, they must identify a package of improvements — changes in signalization, additional lanes, new non-auto facilities, etc. — and develop a plan to finance these improvements. Long-term plans must ensure that the transportation system keeps up with growth or that growth occurs only where it can be supported by the transportation system.

For the traditional definition of trip generation, the amount of automobile travel and its characteristics are functionally related to the use of land. The Institute of Transportation Engineers' (ITE) Trip Generation Manual is the standard tool for estimating the number of motor vehicle trips likely to be generated by a particular land use. Estimates for more than 900 land uses, such as shopping centers, housing developments, and industrial plants, are listed. Equations for estimating motor vehicle trips generated for each land use type are derived from a compilation of as few as two, up to several hundred, trip generation studies previously conducted at various locations throughout the United States and Canada. Aside from the land use trip generator itself, other factors that have been recognized as influencing traditional motor vehicle trip generation include automobile ownership, household income and size, availability of public transportation, density of development, availability of parking, and the quality of the roadway system.

Trip generation and modal split (how the trip is taken) are separate components of the traditional urban transportation process. In practice trip generation has meant automobile trips exclusively. When the issue of trip generation is also concerned with what travel mode — particularly bicycling and walking — is selected, additional factors come into play, such as:

- trip purpose
- trip distance
- bicycle ownership
- the adequacy of the pedestrian and bicyclist circulation networks (how bike/ped "friendly")
- availability and security of bicycle parking at destination
- the individual's age and physical ability to make a non-motorized trip
- weather conditions at trip time

- time of day and illumination
- topography
- previous trip making experience (type of mode generally used)

These influences on non-motorized trip generation are obviously quite variable, in that individuals, infrastructure, climate, and topography are subject to wide fluctuations.

It is apparent that trip generation in the conventional sense as it relates to automobiles is unlike trip generation as it relates to bicycling and walking as defined in the present study. Estimating the number of automobile trips generated from the future building of a library, for example, is focused on the type and size of a particular land use. By contrast, estimating the number of bicyclists that can be expected to use a bicycle lane or path if it is built, is a task which is concerned not only with origins and destinations but also with the transportation facility itself.

Moreover, planning for automobiles is often concerned with building new roads, whereas planning for bicycle use incorporates not only building trails and other facilities but also accommodating bicyclists within the existing, auto-oriented roadway infrastructure.

> Unlike traditional transportation planning that attempts to predict travel demands between future zones on as-yet-unbuilt streets and highways, bicycle planning attempts to provide for bicycle use based on existing land uses assuming that the present impediments to bicycle use are removed. These desire lines are, in fact, well represented by the traffic flow on the existing system of streets and highways. (Wilkinson, Clarke, Epperson, and Knoblauch, 1992).

This section gives five reasons why estimating trip generation for non-motorized modes is different from estimating automobile trip generation.

1. Exogenous factors influence non-motorized travel more so than automobile use.

The many exogenous factors noted earlier, such as perceived and real lack of safety, trip distance, climate, terrain, and cargo and passenger carrying needs that influence an individual's decision to ride a bicycle or walk, do not influence the decision to use an automobile to the same extent. When these factors are favorable for bicycling and walking, their mode share increases. Promotional programs can increase the mode share even more dramatically. This is evidenced by Boulder, Colorado's, 19 and 12 percent share for walking and bicycling, respectively. Since these factors are variable, trip generation estimation of bicycling and walking is not as precise as for automobile travel.

2. There is an incomplete non-motorized infrastructure.

There already exists a fully developed network of roads and other support facilities designed to ensure that motor vehicle travel to any destination is relatively convenient. The infrastructure is not an impediment to automobile trip making.

No similar fully developed infrastructure exists for bicycling, and walking is often hampered by a lack of sidewalks. While bicyclists may, in theory, use all roads, there is usually a "bottleneck" in the bicycling transportation system, such as a road that is too narrow for safe, shared motor vehicle-bicycle use, or a road on which bicycles are lawfully restricted (limited access roadways).

In terms of the trip generation aspects of individual non-motorized facilities, safe and convenient access to the facility in question is itself critical to the use of the facility. For example, constructing a bicycle lane that is stand alone and not part of a larger bicycling compatible network is analogous to building a roadway for automobiles in the middle of an undeveloped field — neither group can reasonably access the facility.

3. The collection of non-motorized use data is problematic.

Collecting bicycle and walking use data is a labor intensive process generally requiring human observers, whereas motor vehicle counting is relatively easy through the use of automatic counting devices. Moreover, the magnitude of automobile travel ensures easy data collection and makes the use of statistics and formulas possible. Non-motorized travel, especially bicycling, is generally so infrequent, except perhaps in some college districts, that this is more difficult.

Because automobile use is so prevalent, it enjoys continual reinforcement as the widely accepted, "only" way to travel. It is the first mode of transportation most adults think about, to the exclusion of the non-motorized modes.

4. Data may not be transferable.

Automobile trip generation rates observed in selected cities can be used to estimate automobile travel in other cities because the rates depend partly on land use. Since external factors, including environmental factors such as climate and terrain, impact heavily on bicycle travel, transferability of bicycle trip generation data from one community to another, or even within the same community at different locations, is tenuous. As an example, whereas automobile trip generation rates in Phoenix, Arizona, may also be applicable in Buffalo, New York, bicycle trip data for the two cities may be totally different. Thus, even if sufficient data were collected to have adequate statistical power within a clearly defined community area, it may not produce meaningful or transferable information.

5. Bicycle use is related to automobile use.

Any prediction of bicycle use must take into account future automobile use. Increases in motor vehicle volume and miles driven may have a negative effect on bicycle use. Similarly, a decrease in motor vehicle use may result in an increase in bicycling.

However, the reverse is not necessarily true. An increase in bicycling will not cause a decrease in motor vehicle use, except to the extent that a bicycle trip displaces an automobile trip.

The Relationship Between Bicycling and Walking Facilities and the Number of Trips Taken

Infrastructure considerations that influence the number of trips taken by bicyclists and walkers include the continuity of the bicycling and walking compatible network (do bicycle lanes and multi-use paths connect with each other and with other bicycle and pedestrian friendly streets?) and the destination serving capacity of the network (can the bicyclist and pedestrians readily access compatible roads, and do these roads lead to places they want to go?). In the present study we are examining the relationship between bicycling and walking facilities – bicycle lanes, paved shoulders, multi-use paths, sidewalks, etc. – and the number 'of bicyclists and pedestrians that use or *may* use each facility. The research question of interest is, "Does building a bicycling or walking facility induce more trips by bicycling and walking?" The studies and data reviewed for this report suggest that considerable latent demand for bicycling and walking will be released if infrastructural impediments to these modes are removed or mitigated. Consider the following examples:

- The 1992 Harris Poll commissioned by Rodale Press (1992) found that there is a large latent demand for transportation bicycling. Of adults surveyed who owned bicycles, roughly half said they would sometimes ride to work if there were safe bicycle lanes or paths. This extrapolates to 40 million people.
- A random digit dialing telephone interview of 600 households in Scottsdale, Arizona, was conducted between February 10 and 15, 1988 (O'Neil Associates, 1988). Sixty-two percent of all households contained at least one person who had ridden a bicycle within the previous year. Of these, 72 percent indicated they would be at least somewhat more likely to ride more often if there were more bicycle lanes, and 46 percent said they would be very likely to do so.

- The "Bicycle Blueprint — A Plan to Bring Bicycling into the Mainstream in New York City," notes the impacts of bicycle facilities on the share of trips made by bicycle.

Every city renowned for cycling in Europe and North America has an extensive network of interconnected city-level and district-level bike paths or lanes, complemented by networks of bicycle-friendly streets shared with cars (at low traffic speeds and volumes) and supporting facilities like bike parking. Indeed, nowhere in industrialized countries does one find significant levels of cycling without street space dedicated to bikes. Copenhagen experienced dramatic growth in commuting and other utilitarian bicycling in the years after it replaced many inner-city parking lanes with curbside bicycle lanes, to 25% of all journeys — an increase of 50% in just five years.

Delft and Groningen in the Netherlands have extensive bikeway systems, complete with overpasses, tunnels, off-ramps, bicycle traffic signals and parking. At least 40% of trips in Delft are made by bicycle; 50% of intra-city journeys in Groningen are bicycle trips, while 20% of commutes from outside city limits are also by bike. In Erlangen, Germany, development of a bicycle lane and path network (combined with motor traffic restraint measures) helped double cycle trips to 30% over a 12-year period. Even more ambitious policies in the large Austrian city of Graz led to a doubling of bike trips to 12% in just three years.

In the United States, cycling has increased similarly in cities that have provided street space for bicycling. Davis, California has long provided facilities and programs for cyclists, including an extensive bike lane system. Although Davis is a university town, almost half of the 25% of Davis commuters who cycle are non-students, giving Davis an impressive commuting level among "ordinary" citizens. Eugene, Oregon, and Palo Alto, California, other university towns, experienced significant increases to bicycling following active official encouragement and bike lane construction. 1980 Census figures of Eugene and Palo Alto showed over 8% and 10% of trips, respectively, made by bike.

Bike lanes encourage utilitarian bicycling in non-university towns as well. One analysis compared major cities with differing ratios of bike lane miles per arterial roadway miles, and found three times as much bike commuting in cities with substantial numbers of bicycle lane-miles as in cities with very few.

Method

We relied upon two primary ways to gather information for this report: (1) a selected literature review and (2) contacts with individuals in communities across the United States known to have active bicyclist and pedestrian programs. For this report, only limited use was made of foreign information.

The ideal was to obtain before/after (with comparison site) usage data where a bicyclist or pedestrian facility had been implemented. From the outset, it was apparent that little data like this exists. Even in localities known for active programs, pedestrian/bicyclist staffing is generally limited, and staff are continually faced with a variety of operational tasks. Data gathering for these non-motorized modes, if not done mechanically, is quite labor intensive and often not a priority among local planning offices.

Even when use data were available, a variety of methods was used to count bicyclists and pedestrians; a standard method did not exist. Examples of counting methods included permanent count locations in multi-use paths, week-long counts using rubber tubes, and short (2–3 hour) to full day (12 hour) manual counts.

Thus, we decided to broaden our information search and ask for bicycling and walking data that might exist in any format (e.g., cordon counts, mode share, trail surveys, etc.). The information in the following chapters reflects this diversity of data sources. By themselves, some of the counts are insignificant — much like single data points — but taken together, the counts are perhaps important in understanding what kind of data collection can and does take place.

Every effort was made to contact the appropriate individuals and obtain any available bicycling and walking data. Probably because bicycle advocacy groups have been active for some time, more count data for bicycle facilities were available than for pedestrian facilities.These data are usually listed by geographic location. A good bit of the pedestrian data were found in older planning textbooks or other special studies.

While this report is broad in scope, it is likely that many additional communities may have bicycling and walking data, in light of the current favorable climate for the development of pedestrian and bicyclist facilities. Nevertheless, we trust that our report proves valuable to the extent of trying to "cover the waterfront" in regard to the types of walking and bicycling use data that exist. The data presented in this report can provide the reader with an idea of the levels of bicycling and walking in a broad spectrum of communities and on a variety of facility types.

CHAPTER 2. URBAN DESIGN FOR PEDESTRIANS AND BICYCLISTS

Introduction

Throughout the United States, urban design accommodates automobiles and encourages their use. Low-density residential subdivisions are often separated from employment and shopping centers by wide streets carrying large volumes of fast-moving motor vehicle traffic. Transit does not serve low densities well, and distances make walking and bicycling impractical for many people. Others do not walk or bike for safety reasons. Bike lanes and bike paths are generally found only in limited areas and do not form a continuous network. Many roads do not have sidewalks or wide shoulders, so pedestrians must walk in the street. This section summarizes six texts that offer suggestions as to how cities can control motor vehicle traffic and become more pedestrian — and bicyclist friendly.

Philosophical Considerations

Appleyard, Gerson, and Lintell (1976) authored "Liveable Urban Streets: Managing Auto Traffic in Neighborhoods" to explain how street traffic impacts residents and what measures can be and have been implemented to mitigate these impacts. They do not provide any information about pedestrian or bicyclist trip generation rates or travel volumes along sidewalks and other infrastructure.

This report begins by examining the problems people in San Francisco have with traffic in their neighborhoods. Two sets of interviews conducted in San Francisco in 1970 and 1974 revealed that heavy traffic induced many people to move away from that street or to withdraw from participation in street life.

Next the authors describe British traffic management programs. These schemes were designed to divert through traffic onto other streets. Many individuals opposed these measures because they perceived themselves as being negatively impacted. The third and fourth sections of the report discuss various engineering schemes that have been implemented in the San Francisco Bay area and in other countries to protect residential neighborhoods.

In the final section, the authors present a conceptual model of traffic impacts on residents. They outline a five-step neighborhood participation process for making streets livable:

1. Analysis of problems.
2. The generation of alternatives.
3. Evaluation of alternatives.
4. Decisions.
5. Experiment, feedback, and modification.

Alternatives for reducing traffic impacts include traffic control schemes and landscaping. The evaluation and selection of alternatives can be done by weighing the cost and benefits of traffic protection schemes.

The authors incorporated much of the above report into a volume entitled Livable Streets (1981). Part One is a social, psychological, and environmental analysis of the effects of traffic on residential life in San Francisco. In the second part, the authors discuss American and international efforts to control traffic. The third part contains the authors' conclusions and recommendations. They state principles for livable streets and protected neighborhoods, and outline a planning process to develop livable streets. As with the earlier report, the book does not include any information about pedestrian and bicyclist volumes. The book appears to have been written to inform local officials of how traffic impacts residents and what programs or engineering treatments can be implemented to reduce these impacts.

Pushkarev and Zupan have conducted valuable research in regard to planning for pedestrians. These authors examined the use of public transportation versus other variables in Public Transportation and Land Use Policy (1977). Perhaps the most important factors relating to demand and use of public transportation were the availability, convenience, and costs associated with using the automobile. Beyond these factors, residential density was found to be an important variable, with density being directly proportional to use of public transportation. Other variables were also correlated with residential density, such as income level and auto ownership. Basically, growth in either residential or non-residential use of space leads to increases in public transportation. The Portland travel demand models explained later in "The Pedestrian Environment" incorporate density measures. As shown in the Portland study, an increase in residential density is one of the factors that decreases vehicle miles of travel per household. In turn, provision of pedestrian amenities leads to increases in walking trips.

Untermann (1984) also wrote a text on how streets and communities can be designed with pedestrians and bicyclists in mind. The second chapter covers aspects of the walking experience — speed, distances, and safety. Planning and constructing street crossings need to take into account the needs and abilities of different groups of users.

Like the texts by Appleyard et al., Untermann offers design guidelines to increase the bicycle- and pedestrian-friendliness of urban streets. Actual data on levels of bicycling and walking are not given and, therefore, do not appear to have influenced the design guidelines. The author discusses how established neighborhoods, downtowns, and suburban communities can be adapted for bicycling and walking. Established neighborhoods can be served by widening sidewalks and slowing down cars by reconfiguring lanes and roadways. Downtowns can be improved by creating auto-free zones for pedestrians and adding amenities. Some adaptations suitable for suburban areas include changing land use patterns, linking sidewalk sections, and reducing car speeds.

The Dutch woonerf concept and examples of its applications are summarized in the first part of Chapter 6 (Transportation and the Pedestrian) in Lennard and Lennard's Livable Cities (1987). With the opening of the subway system in Vienna, Austria, in 1978, pedestrian areas were developed in the historic center. A plan adopted in 1984 called for the reduction of through traffic in residential areas and the development of pedestrian pathways to connect inner-city parks with the outer-green belt. Pedestrian areas in Germany may be characterized either as "making cities profitable" or as "making the city livable." The chapter concludes with a presentation about the importance of walking as a means of transportation, and thus, of adapting the urban environment for the pedestrian.

As part of the National Bicycling and Walking Study, the Project for Public Spaces carried out a case study (1993) to evaluate pedestrian malls, traffic calming, and other downtown design measures intended to increase bicycling and walking, though actual counts of bicyclists and pedestrians are not mentioned. It concludes that projects that stress one function, such as pedestrian or vehicular traffic, over others generally have not fulfilled expectations. Projects that balance the needs of all users have had much higher success. "It is essential to understand and provide for all the users of a downtown environment, while instituting improvements that will foster pedestrian and bicycle use." (p. 36)

The case study also discusses the factors to be considered in creating effective walking and bicycling environments. This part of the case study appears to have been written as a "how-to" manual containing a checklist of items for local officials to keep in mind when planning for bicyclists and pedestrians. Walking environments, for example, should balance street space and uses, offer pedestrian amenities, and create a "sense of place." Bicycling environments should ensure access to downtown areas, provide parking, and incorporate programs to promote bicycling.

CHAPTER 3. EXPOSURE, LEVEL OF SERVICE, AND OTHER CONCEPTS

Introduction

This chapter starts the examination of different kinds of usage data for pedestrians and bicyclists. The topics covered are somewhat peripheral to actual trip counts by type of facility and include some discussion of pedestrian exposure, pedestrian levels of service, and a recreational household survey.

Pedestrian Exposure

Tobey, Shunamen, and Knoblauch (1983) observed the actions of 612,000 vehicles and 61,000 pedestrians at 1,357 sites in five primary sampling units: Brooklyn, New York; St. Louis, Missouri; Seattle, Washington; Tampa, Florida; and Prince Georges/Charles Counties, Maryland. They obtained data on pedestrian characteristics and behavior for an additional 20,000 pedestrians. Pedestrian and vehicle data were collected in 15-minute periods at each site: 6 minutes for vehicle volume and action, 4 minutes for pedestrian activity, and 5 minutes for pedestrian volume. The authors found that 60 percent of pedestrians are male and that 50.5 percent of pedestrians are under 30 years old. During a 16-hour sample day (7 a.m. to 11 p.m.), the busiest hour was 4–5 p.m., which accounted for 9.1 percent of daily pedestrian activity. Among pedestrians who crossed streets, women were more likely than men to use crosswalks (61.4 versus 47.3 percent), while they were less likely to cross midblock than men (25.7 versus 39.6 percent). Pedestrians aged 60 or older were the most likely to cross in crosswalks. Crossing location also varied with land use type, vehicle volumes, signalization, and whether crosswalk markings were present. About one-ninth of pedestrians ran while crossing. The mean time pedestrians were exposed in the roadway was 9.0 seconds for intersection crossings and 15.4 seconds for midblock crossings. Pedestrians who cross midblock often cross diagonally, requiring a longer time in the roadway. They may walk in the roadway until a sufficient gap in the traffic stream appears, allowing them to cross. These pedestrians often have to step into the road to look past parked cars. Women were slightly more likely to cross on a green signal (92.1 versus 89.3 percent).

The report describes pedestrian exposure in terms of pedestrian-vehicle (P x V) interactions — when paths of pedestrians and vehicles cross each other. The authors present numerous tables showing the estimated number of P x V interactions for various locations and characteristics. For example, average weekday P x V exposure at a 100 percent residential site was 75 pedestrian-vehicle interactions per hour. Sites that were 76–100 percent commercial had an average of 5,673 interactions per hour. Higher traffic volumes and pedestrian counts means more likelihood of conflicts and accidents, thus the higher exposure. The average exposure at intersections where right-turn-on-red was prohibited was more than twice as high (11,065 versus 5,271 interactions per hour per site) as those where right-turn-on-red was allowed. Sites with signals had an average exposure of 6,423/hour, compared to 196/hour for sites without signals.

Using police accident counts, site descriptions, and exposure data, hazard scores were calculated to determine the relative hazardousness of various locations and pedestrian characteristics. A positive hazard score indicates that a location or characteristic is relatively hazardous, while a negative hazard score indicates that it is relatively safe. For example, intersections with both traffic lights and pedestrian signals accounted for 24.7 percent of accidents but

58.2 percent of P x V exposure (the other accidents and exposure occurred where there were no signals or only traffic lights). The hazard score is 58.2 divided by 24.7, or -2.4, where the minus sign indicates that intersections with both traffic lights and pedestrian signals were underrepresented in accidents. On the other hand, midblock dart-outs comprised 33.0 percent of pedestrian accidents but only 1.2 percent of all pedestrians observed. The hazard score is 33.0 divided by 1.2, or 27.5, and the positive sign indicates that midblock dart-outs were overrepresented in accidents.

Hazard scores between -1.3 and +1.3 were regarded as neither hazardous nor safe. Intersections with marked crosswalks in both roadways were relatively safe; intersections with no crosswalks were relatively hazardous. The presence of both traffic lights and pedestrian signals made for a relatively safe intersection, while an intersection was relatively hazardous if there were no signals. Pedestrians aged 30–59 were underrepresented in accidents, hence the relatively safe hazard scores. Those pedestrians who crossed at a crosswalk had relatively safe hazard scores, as did those who crossed with the signal. Some pedestrian behaviors, such as walking on a sidewalk and not crossing, are relatively safe. Other behaviors, such as midblock dart-outs or walking in front of a turning/merging vehicle, were relatively hazardous.

Pedestrian Levels of Service

Chapter 13 of the Transportation Research Board's Highway Capacity Manual describes principles of pedestrian traffic flow and presents procedures for the analysis of pedestrian facilities. The analysis procedures are limited to sidewalks, crosswalks, and street corners, and focus on levels of service.

The manual adopts space as the primary criterion for determining a walkway's level of service. Mean speed and flow rate are supplementary criteria (Table 3-1). As a walkway becomes more crowded — less space per pedestrian and more pedestrians per minute per foot of width — pedestrian behavior changes (Figure 3-1). The level of service concept also applies to queueing areas (Figure 3-2).

Seneviratne and Morrall (1985), who collected and analyzed data on walking speeds and flow rates in Calgary, Alberta, Canada, suggest an alternative definition of level of service. They do not present actual counts in their article, though. The observations did not reveal a clear relationship between speed and flow. A survey of pedestrian origins and destinations indicated that less than 1 percent of route selection decisions were influenced by flows and densities. Instead, over 50 percent of pedestrians selected routes according to distance. Based on these findings, the authors suggest that factors other than speed, flow, and space — namely, pedestrians' perceptions of a walkway's attractiveness in terms of shops, open space, security, distance, etc. — should be considered in defining level of service.

Table 3-1. Pedestrian level of service on walkways.*

Level of Service	Space (Sq. ft./Ped)	Expected Flows and Speeds: Ave. Speed, S (ft/min)	Flow Rate, v (ped/min/ft)	Vol/Cap Ratio, v/c
A	≥ 130	≥ 260	≤ 2	≤0.08
B	≥ 40	≥ 250	≤ 7	≤0.28
C	≥ 24	≥ 240	≤10	≤0.40
D	≥ 15	≥ 225	≤15	≤0.60
E	≥ 6	≥ 150	≤25	≤1.00
F	< 6	< 150	...Variable...	

*Average conditions for 15 min.
Source: Transportation Research Board (1985).

Recreational Household Survey

Draft results from a 1992 statewide household survey conducted in Maine (Department of Conservation, Bureau of Parks and Recreation) contained a good bit of summary information. The respondents identified themselves as:

- Urban residents — 22 percent
- Suburban or bedroom community residents — 22 percent
- Rural residents — 56 percent

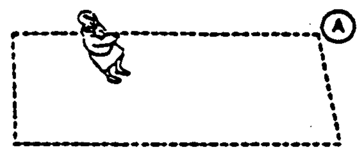
From a list of choices of recreational equipment, 16 percent indicated they owned mountain bicycles, 16 percent touring bicycles, and 47 percent other bicycles. During the year preceding the survey, participation in the following kinds of pedestrian and bicycling activities took place:

Figure 3-1. Illustration of walkway levels of service.

LEVEL OF SERVICE A

Pedestrian Space: ≥ 130 sq ft/ped Flow Rate: ≤ 2 ped/min/ft

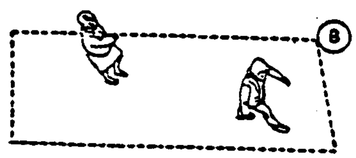
At walkway LOS A, pedestrians basically move in desired paths without altering their movements in response to other pedestrians. Walking speeds are freely selected, and conflicts between pedestrians are unlikely.



LEVEL OF SERVICE B

Pedestrian Space: ≥ 40 sq ft/ped Flow Rate: ≤ 7 ped/min/ft

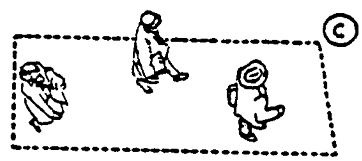
At LOS B, sufficient area is provided to allow pedestrians to freely select walking speeds, to bypass other pedestrians, and to avoid crossing conflicts with others. At this level, pedestrians begin to be aware of other pedestrians, and to respond to their presence in the selection of walking path.



LEVEL OF SERVICE C

Pedestrian Space: ≥ 24 sq ft/ped Flow Rate: ≤ 10 ped/min/ft

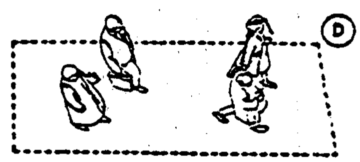
At LOS C, sufficient space is available to select normal walking speeds, and to bypass other pedestrians in primarily unidirectional streams. Where reverse-direction or crossing movements exist, minor conflicts will occur, and speeds and volume will be somewhat lower.



LEVEL OF SERVICE D

Pedestrian Space: ≥ 15 sq ft/ped Flow Rate: ≤ 15 ped/min/ft

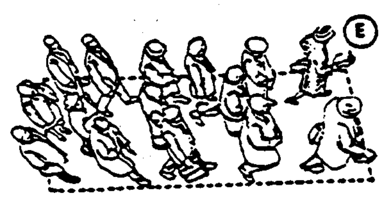
At LOS D, freedom to select individual walking speed and to bypass other pedestrians is restricted. Where crossing or reverse-flow movements exist, the probability of conflict is high, and its avoidance requires frequent changes in speed and position. The LOS provides reasonably fluid flow; however, considerable friction and interaction between pedestrians is likely to occur.



LEVEL OF SERVICE E

Pedestrian Space: ≥ 6 sq ft/ped Flow Rate: ≤ 25 ped/min/ft

At LOS E, virtually all pedestrians would have their normal walking speed restricted, requiring frequent adjustment of gait. At the lower range of this LOS, forward movement is possible only by "shuffling." Insufficient space is provided for passing of slower pedestrians. Cross- or reverse-flow movements are possible only with extreme difficulties. Design volumes approach the limit of walkway capacity, with resulting stoppages and interruptions to flow.



LEVEL OF SERVICE F

Pedestrian Space: ≤ 6 sq ft/ped Flow Rate: variable

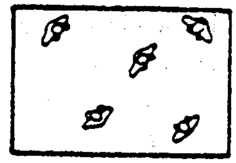
At LOS F, all walking speeds are severely restricted, and forward progress is made only by "shuffling." There is frequent, unavoidable contact with other pedestrians. Cross- and reverse-flow movements are virtually impossible. Flow is sporadic and unstable. Space is more characteristic of queued pedestrians than of moving pedestrian streams.

Source: Transportation Research Board (1985).

Figure 3-2. Levels of service for queuing areas.

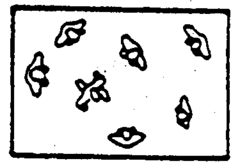
LEVEL OF SERVICE A

Average Pedestrian Area Occupancy: 13 sq ft/person or more
Average Inter-Person Spacing: 4 ft, or more
Description: Standing and free circulation through the queuing area is possible without disturbing others within the queue.



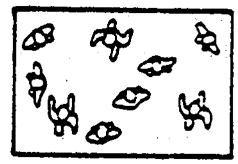
LEVEL OF SERVICE B

Average Pedestrian Area Occupancy: 10 to 13 sq ft/person
Average Inter-Person Spacing: 3.5 to 4.0 ft
Description: Standing and partially restricted circulation to avoid disturbing others within the queue is possible.



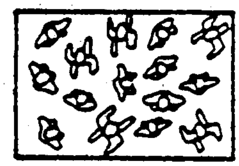
LEVEL OF SERVICE C

Average Pedestrian Area Occupancy: 7 to 10 sq ft/person
Average Inter-Person Spacing: 3.0 to 3.5 ft
Description: Standing and restricted circulation through the queuing area by disturbing others within the queue is possible; this density is within the range of personal comfort.



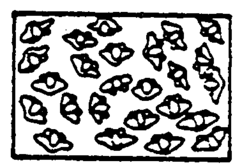
LEVEL OF SERVICE D

Average Pedestrian Area Occupancy: 3 to 7 sq ft/person
Average Inter-Person Spacing: 2 to 3 ft
Description: Standing without touching is possible; circulation is severely restricted within the queue and forward movement is only possible as a group; long term waiting at this density is discomforting.



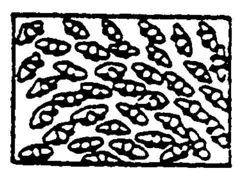
LEVEL OF SERVICE E

Average Pedestrian Area Occupancy: 2 to 3 sq ft/person
Average Inter-Person Spacing: 2 ft or less
Description: Standing in physical contact with others is unavoidable; circulation within the queue is not possible; queuing at this density can only be sustained for a short period without serious discomfort.



LEVEL OF SERVICE F

Average Pedestrian Area Occupancy: 2 sq ft/person or less
Average Inter-Person Spacing: Close contact with persons
Description: Virtually all persons within the queue are standing in direct physical contact with those surrounding them; this density is extremely discomforting; no movement is possible within the queue; the potential for panic exists in large crowds at this density.



Source: Transportation Research Board (1985).

- 25 percent bicycled on paved roads or improved trails
- 2 percent bicycled on long-distance tours
- 8 percent mountain bicycled on unpaved roads/trails
- 58 percent walked for exercise or pleasure
- 29 percent walked on nature/historical interpretive trails
- 15 percent jogged or ran (indoors or outdoors) for exercise
- 20 percent hiked on day trips

In regard to activities of children age 18 or less in the household during the year preceding the survey, 80 percent (85 percent males, 77 percent females) bicycled in their neighborhood, and 17 percent (21 percent males, 14 percent females) bicycled on commuter routes in town. Forty percent (40 percent males, 41 percent females) participated in roller skating (percentage likely includes in-line skating).

The "Pathways for People" poll conducted in December 1991 by Louis Harris conducted 1,255 telephone interviews with adults throughout the continental United States (Rodale Press, 1992). During the year preceeding the poll, 46 percent of the respondents, representing 82 million adults, had ridden a bicycle. Of those who had ridden in the preceding year, 87 percent rode on streets or sidewalks, 41 percent rode on multi-use paths, and 31 percent used designated bike paths. About half of the cyclists indicated they would sometimes commute to work by bicycle if there were safe bike lanes or bike paths, or if there were showers and secure bike storage at work. Among cyclists who rode in the "last mild weather month," 65 percent rode for fitness and 82 percent rode for recreation. Only 15 percent rode to carry out errands and 7 percent rode to work.

In the preceding year, 73 percent had walked outdoors for exercise but only 16 percent had walked as the sole means of transportation to and from work. Eighty-two percent walked on streets or sidewalks, 31 percent walked on multi-use paths, and 41 percent used designated walking paths. Slightly over half of all respondents said they would walk more often if there were safe paths or walkways or if crime were not a factor.

About one-fourth of the respondents ran or jogged in the past year. As with cyclists and walkers, they were more likely to use streets or sidewalks (74 percent) rather than multi-use paths (37 percent) or designated running paths (34 percent). Of those who ran or jogged, slightly more than half indicated they would do so more often if there were designated paths, if showers and other facilities were available at work, or if crime were not a factor.

Three-fifths of all respondents wanted their government to spend more on bicycle and pedestrian facilities. Seventy-two percent wanted a local planning structure to make walking, running, and bicycling an integral part of their area's transportation system.

CHAPTER 4. BICYCLE TRIP COUNTS

Introduction

Counts of bicycle trips or users were obtained from many places. The following text provides discussion of these data. Geographical, rather than subject, headings are used to orient the reader.

Site Descriptions

College Park, Maryland

A detailed study was performed by the Transportation Studies Center and the Department of Civil Engineering at the University of Maryland on five demonstration bikeways built by the Maryland State Highway Administration (Takacs and Mulinazzi, 1979). Bicyclist counts and user surveys addressed the following issues:

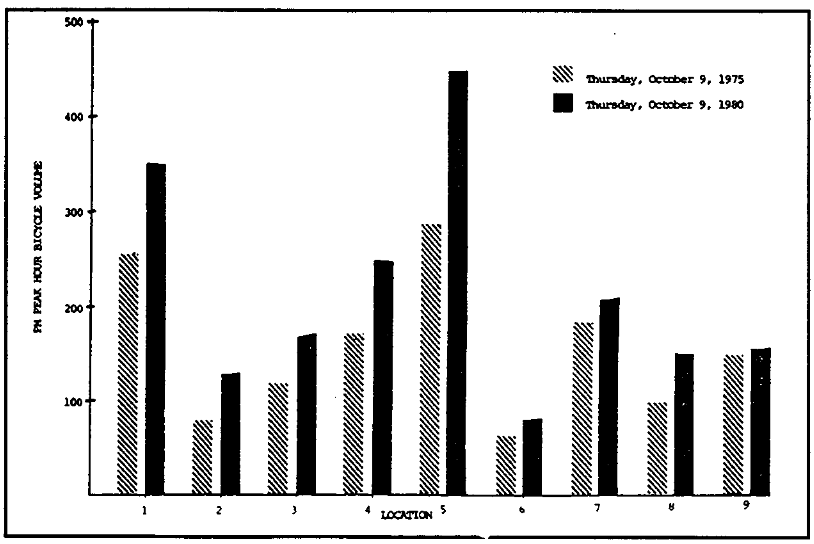
1. Bicycle ADT,
2. Percentage of bicyclists that would not have made their trip if the bikeway did not exist,
3. Percentage of bicyclists that would have used the same route if the bikeway did not exist,
4. Percentage of bicyclists who rode the same route prior to the bikeway development,
5. Percentage of bicycle riding done on the bikeway.

The authors concluded that the development of the bikeways clearly attracted bicyclists. No more than 34 percent of the bicyclists interviewed on any bikeway had ridden the route prior to the establishment of the bikeway. About one-third of the bicyclists indicated they would not have made the trip or would have used a different mode of travel if the bikeway did not exist.

Boston, Massachusetts

Figure 4-1 shows the growth in bicycle traffic at nine intersections in the Boston area between two observations taken exactly 5 years apart, with similar weather conditions (Buckley, 1982). The total

Figure 4-1. Growth in bicycle traffic, 1975–1980.



Source: Buckley (1982).

evening peak-hour volumes for the nine intersections was 1,922 in 1980 — 40 percent higher than in 1975. At four of these intersections, bicycle traffic was also counted in 1985 and 1990 (Table 4-1) (Buckley, 1991). The volumes rose at all four intersections 1975–1985, then declined. The combined peak hour volume at these four sites rose from 763 in 1975, to 1,049 in 1980, and 1,153 in 1985, then fell to 987 in 1990. Counts made in 1975, 1980, and 1990 at four intersections in Cambridge also showed an increase 1975–1980. At three of the four intersections, volumes also increased 1980–1990, in contrast to the four sites initially mentioned.

The total morning peak-hour bicycle volume for four intersections in 1981 was 575 — 57 percent higher than exactly 5 years earlier, with nearly identical weather (Figure 4-2).

During a 1-day transit strike in July 1978, bicycle volumes were 2–4 times higher than the following week (Figure 4-3). Buckley suggests that many commuters have bicycles available for their use when their regular modes are unavailable.

Figure 4-4 depicts seasonal variations. The average for the three counts in March was 60. The June counts were about 3 times higher, and the July counts 4 times higher.

At two sites, the morning peak hour volume with fog and light rain was about 90. On a partly sunny morning with the same temperature one week later peak hour volume was 140 at one site and 180 at the other site (Figure 4-5).

The highest hourly volumes were recorded between 5 and 6 p.m. and 8 and 9 a.m. at two sites (Figures 4-6 and 4-7). In May 1981, the volumes at Coolidge Corner, west of downtown Boston, ranged from about 40 between 12 noon and 1 p.m., to 220 between 5 p.m. and 6 p.m. The minimum of 50 at Charles Circle was observed between 11 a.m. and 12 noon. Maximums of 130 were counted during the morning and afternoon peak hours.

The 1976 average daily bicycle volumes were highest near Boston University (1,200) and MIT (1,150). The Harvard area had 500–700 cyclists/day. Volumes on several arterials into downtown Boston were around 400/day.

Providence, Rhode Island

Brownell (1982) estimated bicycle usage of a proposed 14.5 mile bicycle facility between Providence and Bristol, Rhode Island. He relied upon the following trip generation equations:

Trips (1) = 4.9 x employment/1000
Trips (2) = 20.3 x school enrollment/1000
Trips (3) = 112.9 x population/1000
Total Trips = Trips (1) + Trips (2) + Trips (3)

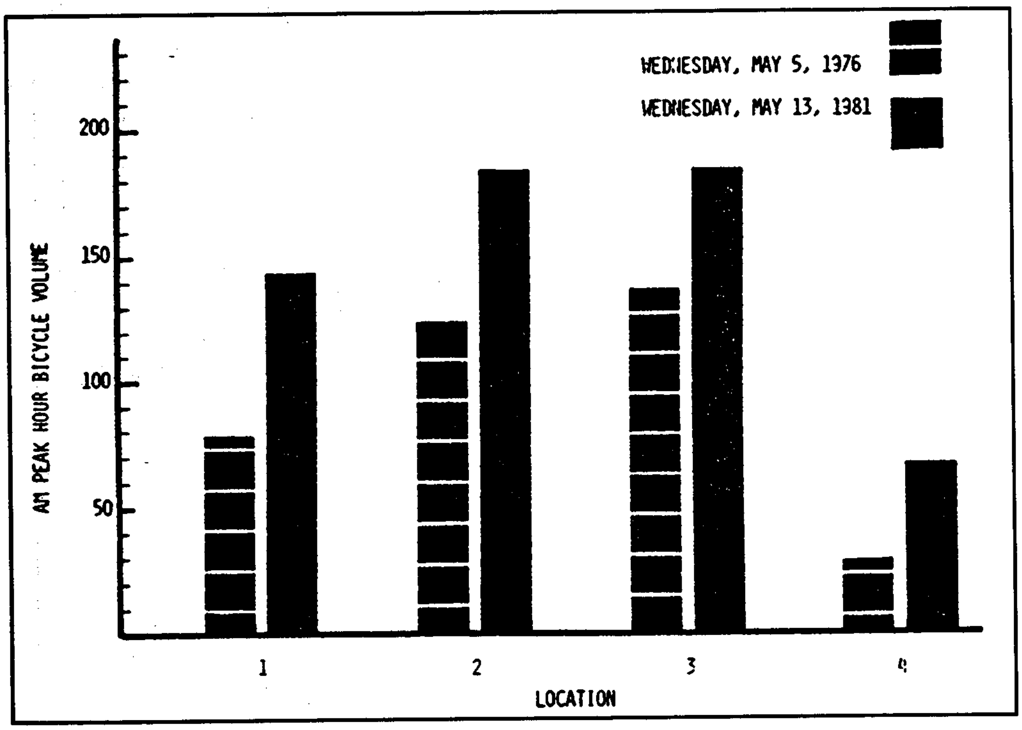
Table 4-1. Peak-hour bicycle volumes at selected intersections, 1975–1990.

Location	Thursday 10/9/75	Thursday 10/9/80	Wednesday 10/9/85	Tuesday 10/16/90
Arlington Center	NC	59 (5:15)	NC	55 (5:15)
Boston				
BU Bridge @ Commonwealth Ave	257 (4:15)	344 (4:45)	385 (5:15)	368 (4:45)
Beacon and Charles	78 (3:45)	125 (5:15)	160 (5:15)	114 (4:45)
Longfellow Bridge @ Esplanade	NC	NC	267 (5:00)	234 (5:15)
Kenmore Square	115 (4:45)	170 (4:30)	213 (5:00)	NC
Cambridge				
Memorial Drive @ Mass Ave	284 (4:30)	429 (4:45)	447 (5:00)	364 (5:00)
Longfellow Bridge @ Memorial Drive	74 (5:00)	80 (5:00)	NC	99 (5:00)
Mass Ave @ Main Street	182 (4:00)	207 (4:45)	NC	175 (5:15)
Porter Square	95 (4:30)	148 (5:00)	NC	176 (5:30)
Memorial Drive @ JF Kennedy	164 (5:00)	248 (5:15)	NC	359 (4:45)
Brookline				
Coolidge Corner	144 (5:00)	151 (4:45)	161 (5:30)	141 (5:30)

NC = not counted

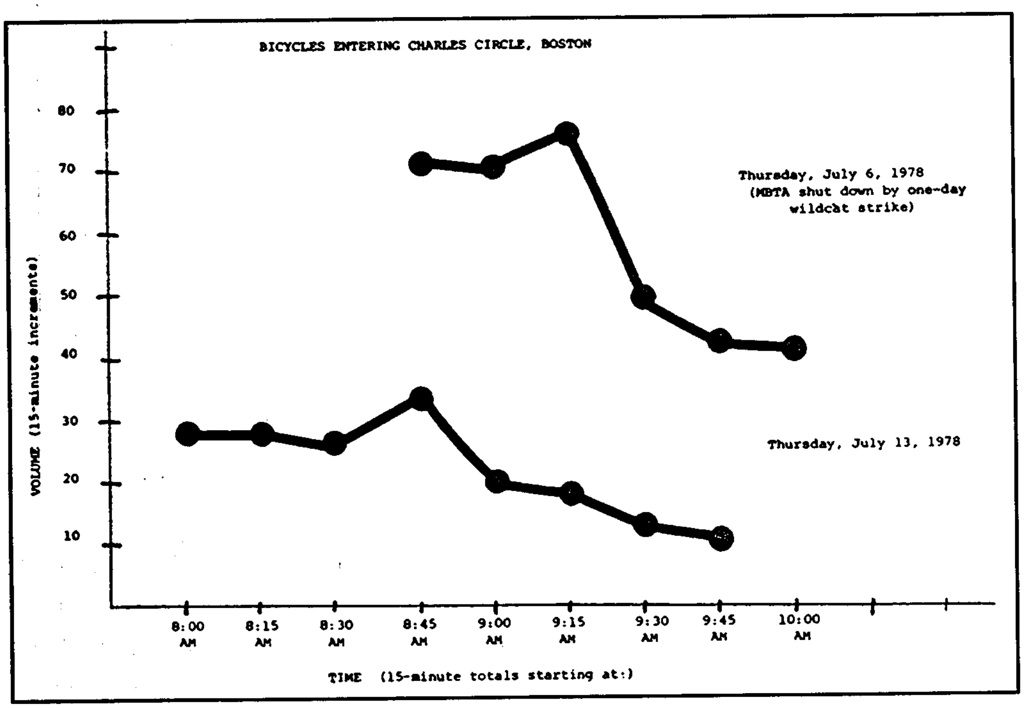
Source: Buckley (1991).

Figure 4-2. Growth in bicycle traffic, 1976–1981.



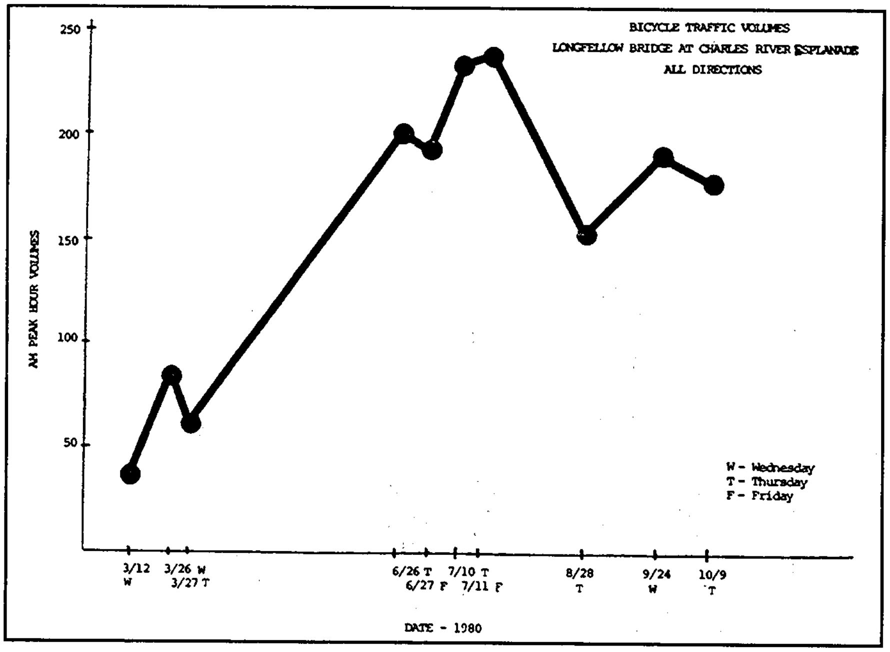
Source: Buckley (1982).

Figure 4-3. Effects of transit strike on bicycle traffic.



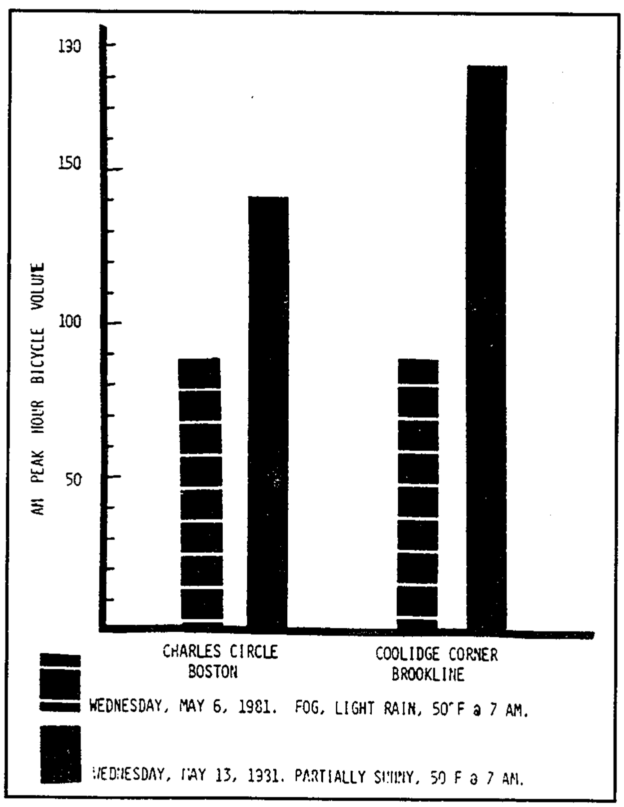
Source: Buckley (1982).

Figure 4-4. Seasonal variations on Longfellow Bridge at Charles River Esplanade.



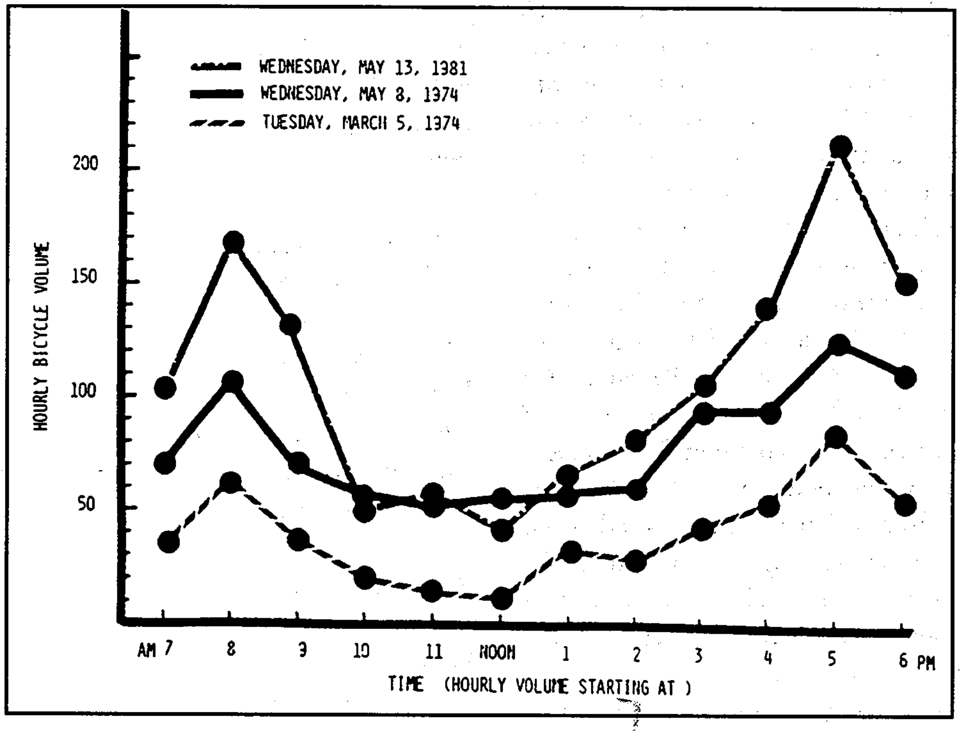
Source: Buckley (1982).

Figure 4-5. Effect of rain of bicycle volumes.



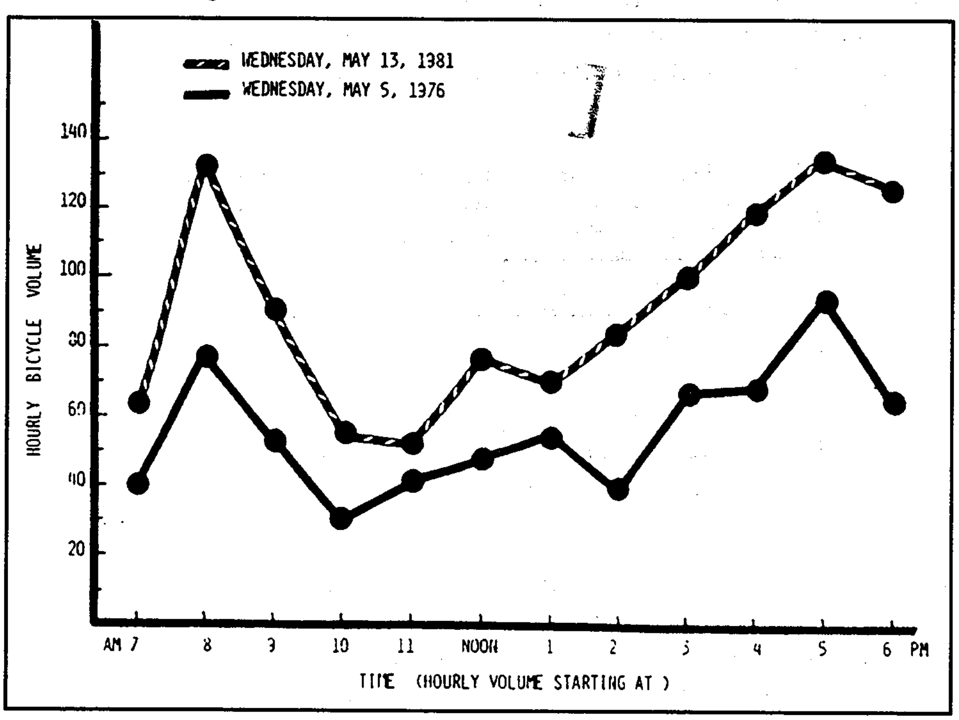
Source: Buckley (1982).

Figure 4-6. Twelve-hour volumes, Coolidge Corner.



Source: Buckley (1982).

Figure 4-7. Twelve-hour volumes, Charles Circle.



Source: Buckley (1982).

The author used those equations to estimate the total number of bicycle trips generated by each analysis zone in the facility's area of influence. According to the equations, 4.9 daily bicycle trips are generated for every 1,000 employees working in an analysis zone and 20.3 daily bicycle trips are generated for every 1,000 people who attended schools located in an analysis zone. Every 1,000 people living in an analysis zone make 112.9 bicycle trips daily riding for recreation, to visit friends, and for other purposes. The Rhode Island Department of Transportation (1991) did not actually build this bicycle path until 1990, 8 years later. Bicyclists and pedestrians were manually counted at five intersections spread along the bike path. Counts were taken weekdays from 5–7 p.m. and weekends from 9–11 a.m. The counts were adjusted to estimate the average daily bicycle traffic (ADBT). The data showed an average modal split of 80 percent bicycles and 20 percent pedestrians.

Brownell assumed that one-fourth of all bicycle trips generated within the area of influence would be attracted to the path. He estimated average daily bicycle volumes for 1980 — if the path had been built then — ranging from 250 at the southern end (Bristol) to 370 about two-thirds of the way (Providence/Barrington border) to the northern end. By the year 2000, these two sections were projected to have 275 and 390 users per day. In actuality, bicycle volumes at these sections in 1991 were only 225 and 325, but volumes at three other sections already exceeded the projections for the year 2000.

Davis, California

The installation of an on-street bicycle lane in 1974 along Anderson Road in Davis, California, affected bicyclists' route selection (Lott, Tardiff, and Lott, 1978). Bicycle counts were taken along Anderson Road, Sycamore Lane, and Oak Avenue a few weeks before and 1 week after the bicycle lane was painted onto Anderson Road. The three-hour (7:30 – 8:30 a.m. and 3:30 – 5:30 p.m.) ridership increased by 103 each on Anderson Road and Sycamore Lane and by 95 on Oak Avenue. However, there was a marked increase in riding among cyclists 25 years and older. Along Anderson Road, the number of riders 25 and older increased by 87 percent (Table 4-2). These cyclists perceived the greatest degree of improvement for bicycle use with the bicycle lane. College-age cyclists perceived the least improvement and were least likely to change their routes to use the bicycle lane.

Table 4-2. Bicycle ridership before and after a bicycle lane was painted onto Anderson Road.

Route	Number of Riders 25 Years and Older		Percent Change
	Before	After	
Anderson Road	255	477	87.1
Oak Avenue	240	364	51.7
Sycamore Lane	134	145	8.2

Source: Lott, Tardiff, and Lott (1978).

Interviews with 108 cyclists living near the University of California, Davis revealed that 53 rode on Anderson Road before the bicycle lane was added. Afterwards, 78 rode on Anderson Road, indicating that 45 percent of the cyclists who had used other routes before switched to Anderson Road.

Chula Vista, California

During the summer of 1980, CALTRANS counted bicycles at 21 selected intersections in Chula Vista, California (population 135,000) (Bicycle Route Facilities Report, 1981). These counts did not include trips by schoolchildren or weekend recreational trips. Average hourly counts ranged from 8.3 to 49.3, with 10 intersections experiencing average hourly counts of 20 or higher. Peak hour volumes ranged from 11 to 70. For eight intersections, the peak hour was 3–4 p.m. Twelve-hour bicycle counts at seven intersections ranged from 101 to 335.

Sacramento, California

The Office of Bicycle Facilities[1] within the California Department of Transportation was helpful in attempting to locate relevant information from selected cities in California. Descriptions are provided below.

Chico, California. The City of Chico is located in the northern Sacramento Valley and has a population of about 40,000 (population of entire urban area about 80,000) and an average population density of 4,000 persons per square mile. With a flat terrain, mild climate, and the presence of California State University, Chico (CSUC) with about 16,000 students located at the northern fringe of the CBD, the area has high levels of bicycle use. City staff made bicycle counts at various locations in 1988 and found bicycle volumes exceeding 1,000 per day on several streets accessing CSUC. Counts for other desirable routes are shown in Table 4-3.

Davis, California. The City of Davis, located in northern California, has a population of about 55,000 with about 23,000 students and faculty at the University of California, Davis. The area has some of the highest bicycle use in the country. Several volume/user surveys have been conducted on the university campus. Details were provided from a survey conducted on Wednesday, October 19, 1988, by local bike program staff and volunteers. This survey focused on the number of bicycles entering or exiting campus during peak hours, bicycle traffic flow within the main core, and the bicycle parking population around high-use areas.

An early morning count of bicycles parked near campus buildings and housing units yielded a total of 6,007. Counts at busy intersections yielded volumes between 2,000–4,000 bicycles per hour. A recent paper by Burden et al. (1994) refers to projected flow rates of 9,000–11,000 bicycles per hour at a roundabout intersection at Hutchinson and California streets on the Davis campus.

A survey (Wilbur Smith Associates, 1991) reported in a travel demand management study (Comsis Corporation et al., 1993) shows the proportion of people from different sectors using the bicycle as either a primary or alternate mode of transportation (Table 4-4). The report states:

[1]Personal contacts with Rick Blunden and Ken McGuire.

sed those equations to estimate the of bicycle trips generated by each in the facility's area of influence. the equations, 4.9 daily bicycle trips for every 1,000 employees working in ıne and 20.3 daily bicycle trips are gen- :ry 1,000 people who attended schools analysis zone. Every 1,000 people liv- ıalysis zone make 112.9 bicycle trips for recreation, to visit friends, and for ;es. The Rhode Island Department of on (1991) did not actually build this until 1990, 8 years later. Bicyclists and were manually counted at five intersec- l along the bike path. Counts were lays from 5–7 p.m. and weekends from The counts were adjusted to estimate the ly bicycle traffic (ADBT). The data average modal split of 80 percent bicy- percent pedestrians.

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:n in

Solwileno & Children's Park Bridge (Class I bikeway)
17
74
26
18
15
56
206
21
90
26
24
19
180
15
14
97
61
34
20
241
206
180
241
627

Guire.

These data indicate that a substantial number of people from different sectors are commuting by bicycle, either as their primary mode or as their principal alternative. This can be seen as evidence that non-student mass cycling does occur, since the percentage claiming to bicycle commute in each category is greater than the total proportion of bike commuters in most other cities. The mere presence of a major university alone cannot by itself account for such a high proportion of active, non-student commuter cyclists. It is almost certain that these high rates in Davis are due to a set of proactive policies and programs, many of which were inspired by the decision of UC-Davis back in the 1960's to minimize the presence of cars on campus. These policies include:

- Construction of an extensive, 56-mile linked network of bike lanes;
- Bicycle registration requirements;
- Active enforcement of bicycle and motor vehicle laws;
- Very high parking fees at the UC-Davis campus; and
- Development patterns which enhance access to bicycling facilities and reduce reliance on the automobile.

Each of these features serves to legitimize and institutionalize bicycling as a viable transportation option. Though it is difficult to separate the effects of these programs from other features that make Davis attractive for cycling — such as a warm, dry climate, flat terrain, a compact area, short average commutes, and a young population — studies of comparably sized, similarly situated towns where bicycle commuting takes place suggest that active policies are the difference.

Table 4-4. Percent using bicycle as a primary and alternate mode of transportation in Davis, California.

	Bicycle as Primary Mode	Bicycle as Alternate Mode
Student	53%	N/A
UC Davis Employees	27%	31%
City Employees	6%	37%
School District	9%	46%
Private Sector Workers	7%	29%

Source: Wilbur Smith Associates (1991).

San Diego, California

Bicycle counts were taken at major street intersections in San Diego County in 1987 and 1990 as part of the Regional Bicycle Counting Program. The data have been used to plan for and provide a regional network of bicycling facilities to facilitate commuting by bicycle (San Diego Association of Governments, 1991). Six-hour counts were taken by directional movement at 71 intersections during September, October, and November of 1990. Counts were performed in the morning from 6–9 a.m. and in the afternoon from 3–6 p.m., Monday through Thursday.

A number of tables are provided in the report. Table 4-5 summarizes the counts by location and other variables. The largest 6-hour total was at Montezuma and College, near San Diego State University, where 712 bicycles (or an average of 119 per hour) were observed. Next highest total was Lomas Santa Fe Drive and Pacific Highway with 374 bicycles (an average of 62 per hour).

Table 4-6 shows average number of riders by hour of day. The lowest average was 12 per hour occurring from 6–7 a.m.; the highest average was 28 per hour occurring from 5–6 p.m.

Table 4-7 shows peak hour information by location. The time of 5–6 p.m. was the peak hour in 23 of the 71 locations.

Table 4-8 compares bicycle use in 1990 with the counts taken in 1987. The sites listed below are cited in the report as having significant increases in bicyclists. All but one are linked with better facilities for bicycling:

Pomona Avenue and Orange Avenue. Bicycle use increased 80 percent at the northern terminus of the Bay Route Bikeway in Coronado because of increased knowledge of the facility and completion of the Bikeway under the San Diego-Coronado Bay Bridge.

Ferry Boat Landing and Harbor Drive. Continued successful operation of the San Diego-Coronado pedestrian/bicycle ferry produced an increase in cycling of over 90 percent in this area.

Greenfield Drive and Main Street. Completion of a San Diego County bike lane facility on Greenfield Drive helped to increase the number of cyclists by nearly 170 percent at this location.

Table 4-5. Summary of bicycle counts in San Diego.

	SITE	EAST – WEST	NORTH – SOUTH	ZIP	DAY	600 TO 900	1500 TO 1800	SIX HOUR TOTAL	PEAK HOUR BEG	PEAK HOUR VOL	AVERAGE HOURLY COUNT ADULT	CHILD	SUB TOTAL	MOPED	TOTAL
	921	BONITA RD	OTAY LAKES RD	92002	MON	25	48	73	1700	19	9.9	0.9	10.8	1.5	12.2
*	831	TAMARACK AVE	CARLSBAD BLVD	92008	TUE	74	185	259	1700	71	37.7	3.7	41.4	1.9	43.2
	935	ELM AVE	CARLSBAD BLVD	92008	WED	109	184	293	1700	77	42.2	2.7	44.9	4.0	48.9
	933	POINSETTIA LANE	CARLSBAD BLVD	92009	MON	52	126	178	1700	55	26.9	1.0	27.9	1.9	29.7
	934	PALOMAR AIRPORT RD	PASEO DEL NORTE	92009	WED	32	61	93	1700	32	14.2	0.2	14.4	1.2	15.5
*	829	H ST	FIFTH AVE	92010	MON	43	66	109	1500	31	9.0	6.9	15.9	2.4	18.2
*	833	L ST	HILLTOP DR	92010	WED	23	48	71	1500	20	7.2	3.4	10.6	1.4	11.9
*	837	D ST	THIRD AVE	92010	WED	9	21	30	1700	10	3.9	0.4	4.3	0.9	5.0
	920	EAST H ST	OTAY LAKES RD	92010	THUR	35	50	85	1500	23	4.9	8.4	13.3	1.0	14.2
	924	J ST	BAY BLVD WEST	92010	THUR	46	53	99	600	29	14.2	0.9	15.1	1.5	16.5
	925	TELEGRAPH CANYON RD	HILLTOP DR	92010	THUR	26	28	54	700	15	2.7	4.9	7.6	1.5	9.0
	926	F ST	BAY BLVD WEST	92010	WED	32	55	87	1600	23	12.7	1.2	13.9	0.7	14.5
	931	H ST	ROHR ENTRANCE	92010	WED	35	51	86	1500	27	13.2	0.0	13.2	1.2	14.4
	932	J ST	BROADWAY	92010	WED	49	109	158	1600	37	20.9	2.9	23.8	2.7	26.4
	923	OTAY VALLEY RD	I–805	92011	MON	5	7	12	1700	4	1.4	0.5	1.9	0.2	2.0
	927	NAPLES ST	THIRD AVE	92011	TUE	33	69	102	1700	26	11.9	4.0	15.9	1.2	17.0
	928	E ORANGE AVE	HILLTOP DR	92011	MON	12	40	52	1800	17	2.2	5.9	8.1	0.7	8.7
	929	ORANGE AVE	FOURTH AVE	92011	MON	20	42	62	1600	18	6.5	2.2	8.7	1.7	10.4
	930	L ST	FOURTH AVE	92011	MON	28	71	99	1500	33	6.7	8.9	15.6	1.0	16.5
	922	TELEGRAPH CANYON RD	OTAY LAKES RD	92013	TUE	5	13	18	1500	8	2.7	0.0	2.7	0.4	3.0
*	812	BRADLEY AVE	CUYAMACA ST	92020	THUR	29	27	56	600	14	5.9	1.9	7.8	1.7	9.4
*	813	FLETCHER PARKWAY	JOHNSON AV	92020	THUR	57	74	131	1600	30	16.7	3.0	19.7	2.2	21.9
	911	CHASE AVE	AVOCADO BLVD	92020	MON	34	66	100	1500	25	6.0	8.9	14.9	1.9	16.7
	915	E LEXINGTON AVE	MOLLISON AVE	92020	TUE	37	80	117	1500	31	13.2	5.5	18.7	0.9	19.5
	916	FLETCHER PARKWAY	HACIENDA/WESTWIND DR	92020	THUR	38	64	102	1700	28	11.0	3.5	14.5	2.5	17.0
	918	W MAIN ST	EL CAJON BLVD	92020	TUE	26	68	94	1700	29	12.2	3.4	15.6	0.2	15.7
	912	MADISON AVE	FOURTH ST	92021	THUR	26	44	70	1600	21	7.4	3.0	10.4	1.4	11.7
	913	GREENFIELD DR	MAIN ST	92021	THUR	50	119	169	1700	68	16.0	1.2	17.2	11.0	28.2
	914	SECOND ST	BROADWAY	92021	MON	49	109	158	1600	41	10.7	12.7	23.4	3.0	26.4
	917	WASHINGTON AVE	JAMACHA RD	92021	THUR	29	99	128	1500	37	9.4	10.4	19.8	1.7	21.4
*	814	ENCINITAS BLVD	PACIFIC HIGHWAY	92024	TUE	55	93	148	1700	39	18.4	4.2	22.6	2.2	24.7
*	819	LOMAS SANTA FE DR	PACIFIC HIGHWAY	92024	THUR	171	203	374	700	97	56.9	2.5	59.4	3.0	62.4
*	807	VALLEY PARKWAY	ASH ST	92025	THUR	41	79	120	1600	33	14.4	4.5	18.9	1.2	20.0
	803	GILMAN DR	ROSE CANYON BIKE PATH	92037	THUR	93	134	227	1700	64	37.5	0.0	37.5	0.4	37.9
	835	TORREY PINES RD	GENESEE AVE	92037	MON	85	121	206	1600	51	30.5	0.0	30.5	3.9	34.4
*	801	UNIVERSITY AVE	SPRING ST	92041	TUE	28	56	84	1700	31	11.2	0.9	12.1	2.0	14.0

* Master Bicycle Count Locations

Table 4-5 continued.

SITE	EAST – WEST	NORTH – SOUTH	ZIP	DAY	600 TO 900	1500 TO 1800	SIX HOUR TOTAL	PEAK HOUR BEG	PEAK HOUR VOL	AVERAGE HOURLY COUNT ADULT	CHILD	SUB TOTAL	MOPED	TOTAL
* 811	UNIVERSITY AVE	70TH ST	92041	WED	62	77	139	1600	31	14.2	4.9	19.1	4.2	23.2
938	LEMON AVE	BANCROFT DR	92041	TUE	9	34	43	1500	14	4.5	1.2	5.7	1.5	7.2
936	LAKE MURRAY BLVD	BALTIMORE DR	92042	WED	42	65	107	1500	27	10.7	3.2	13.9	4.0	17.9
937	AMAYA DR	SEVERIN DR	92042	TUE	93	114	207	1500	56	21.9	7.9	29.8	4.9	34.5
* 800	BROADWAY	MASSACHUSETTS AVE	92045	TUE	35	44	79	1600	17	7.7	4.2	11.9	1.4	13.2
939	8TH ST	NATIONAL CITY BLVD	92050	TUE	61	63	124	600	39	19.0	0.0	19.0	1.7	20.7
940	8TH ST	EUCLID AVE	92050	TUE	21	46	67	1500	21	7.5	2.4	9.9	1.4	11.2
941	30TH ST	NATIONAL CITY BLVD	92050	TUE	47	67	114	1700	30	14.7	1.9	16.6	2.5	19.0
942	SWEETWATER RD	PLAZA BONITA RD	92050	THUR	11	20	31	1500	8	4.7	0.4	5.1	0.2	5.2
* 808	OCEANSIDE BLVD	HILL ST	92054	THUR	41	100	141	1500	38	17.0	5.5	22.5	1.0	23.5
834	POWAY RD	COMMUNITY RD	92064	TUE	29	110	139	1600	48	10.4	11.0	21.4	1.9	23.2
805	MISSION GORGE RD	MAGNOLIA AVE	92071	TUE	75	93	168	700	42	18.0	9.7	27.7	0.4	28.0
906	BEYER BLVD	DAIRY MART RD	92073	TUE	22	70	92	1600	28	6.4	7.7	14.1	1.4	15.4
944	SHADOWRIDGE DR	SOUTH MELROSE DR	92083	TUE	22	27	49	1700	14	4.2	2.9	7.1	1.2	8.2
945	OLIVE AVE	NORTH MELROSE DR	92083	TUE	29	46	75	1600	20	6.2	5.2	11.4	1.2	12.5
946	WEST BOBIER DR	NORTH SANTA FE	92083	WED	33	58	91	1700	26	7.5	7.2	14.7	0.5	15.2
943	EAST VISTA WAY	VALE TERRACE DR	92084	WED	23	46	69	1700	18	7.7	2.7	10.4	1.2	11.5
836	HARBOR DR	PACIFIC HIGHWAY	92101	WED	49	68	117	1700	29	17.9	0.4	18.3	1.4	19.5
907	FERRY BOAT LANDING	HARBOR DR	92101	MON	49	173	222	1700	106	29.4	4.4	33.8	3.4	37.0
900	IMPERIAL AVE	EUCLID AVE	92102	WED	31	40	71	700	16	6.0	3.5	9.5	2.4	11.9
* 822	LAUREL ST	SIXTH AV	92103	TUE	70	92	162	1500	34	21.7	1.7	23.4	3.7	27.0
905	MONTECITO PL	BACHMAN PL	92103	MON	23	35	58	1600	17	8.2	0.0	8.2	1.5	9.7
* 824	HOWARD AVE	IDAHO ST	92104	THUR	39	74	113	1500	30	15.4	2.0	17.4	1.5	18.9
901	CLAIREMONT DR	EAST MISSION BAY DR	92109	MON	96	109	205	1700	54	31.9	1.2	33.1	1.2	34.2
* 820	BALBOA AV	GENESEE AVE	92111	MON	40	98	138	1500	37	14.2	4.2	18.4	4.7	23.0
902	HARBOR DR	28TH ST	92113	THUR	66	71	137	600	33	21.0	0.0	21.0	1.9	22.9
809	MONTEZUMA RD	COLLEGE AVE	92115	WED	312	400	712	1500	175	101.7	1.5	103.2	15.5	118.7
910	CAMINO DEL RIO S	FAIRMOUNT AVE	92115	FRI	80	115	195	1600	43	29.5	0.0	29.5	3.0	32.5
* 832	POMONA AVE	ORANGE AVE	92118	MON	120	188	308	1700	77	45.7	4.4	50.1	1.4	51.4
919	NAVAJO RD	FANITA DR	92119	WED	38	76	114	1500	35	9.0	8.0	17.0	2.0	19.0
* 817	MIRA MESA BLVD	BLACK MOUNTAIN RD	92126	TUE	120	119	239	700	80	14.5	22.2	36.7	3.2	39.9
909	RANCHO BERNARDO RD	BERNARDO CENTER DR	92128	MON	13	15	28	700	10	4.2	0.4	4.6	0.2	4.7
904	POWAY RD	I–15 BIKEWAY	92129	TUE	23	45	68	1700	18	11.4	0.0	11.4	0.0	11.4
908	PARADISE VALLEY RD	WOODMAN ST	92139	WED	26	40	66	1500	19	6.0	3.2	9.2	1.9	11.0
903	PALM AVE	19TH ST	92154	MON	43	.120	163	1500	46	17.5	8.7	26.2	1.0	27.2

* Master Bicycle Count Locations

Source: San Diego Association of Governments (1991).

Table 4-6. Average number of riders at all stations by hour of day and age of rider.

HOUR	ADULT	CHILD	BIKE	MOPED	TOTAL
600-700	10.27	1.16	11.24	0.96	12.39
700-800	13.79	4.46	15.57	1.78	20.02
800-900	13.30	1.39	14.60	1.30	15.98
1500-1600	17.02	6.44	19.80	2.78	26.23
1600-1700	19.06	4.79	21.93	2.86	26.71
1700-1800	20.68	4.27	23.39	2.71	27.65
TOTAL	15.72	3.77	19.44	2.07	21.56

Source: San Diego Association of Governments (1991).

J Street and Broadway. Continued development of the Chula Vista bayfront and increased usage of the Bay Route Bikeway helped boost ridership by about 70 percent in this coastal area.

Valley Parkway and Ash Street. Continued residential and commercial growth in this Escondido community helped to increase the number of cyclists by over 110 percent at this location.

Oceanside Boulevard and Hill Street. Cycling increased over 50 percent in this area due to growth in use of the Pacific Coast Bike Route.

Eugene, Oregon

Eugene (population 117,000) is centrally located in Oregon and is home to the University of Oregon and its 18,000 students. The community has had a bicycle coordinator in place for some time and is considered to be pro-active for bicycling. Over the years different kinds of bicycle count data have been obtained. Interestingly, bicycle volume maps have been produced.

The Eugene City Council adopted the Eugene Bikeways Master Plan in 1975 (Bikeways Oregon, 1981). The plan proposed 120 routes covering 150 miles. By 1981, 70 miles of bike paths, on-street lanes, and signed routes were in place.

Table 4-7. Peak hour usage by station, highest to lowest.

EAST – WEST	NORTH – SOUTH	ZIPCODE	PEAK HOUR BEG	PEAK HOUR USAGE
MONTEZUMA RD	COLLEGE AVE	92115	1500	175
FERRY BOAT LANDING	HARBOR DR	92101	1700	106
LOMAS SANTA FE DR	PACIFIC HIGHWAY	92024	700	97
MIRA MESA BLVD	BLACK MOUNTAIN RD	92126	700	80
ELM AVE	CARLSBAD BLVD	92008	1700	77
POMONA AVE	ORANGE AVE	92118	1700	77
TAMARACK AVE	CARLSBAD BLVD	92008	1700	71
GREENFIELD DR	MAIN ST	92021	1700	68
GILMAN DR	ROSE CANYON BIKE PATH	92037	1700	64
AMAYA DR	SEVERIN DR	92042	1500	56
POINSETTIA LANE	CARLSBAD BLVD	92009	1700	55
CLAIREMONT DR	EAST MISSION BAY DR	92109	1700	54
TORREY PINES RD	GENESEE AVE	92037	1600	51
POWAY RD	COMMUNITY RD	92064	1600	48
PALM AVE	19TH ST	92154	1500	46
CAMINO DEL RIO S	FAIRMOUNT AVE	92115	1600	43
MISSION GORGE RD	MAGNOLIA AVE	92071	700	42
SECOND ST	BROADWAY	92021	1600	41
8TH ST	NATIONAL CITY BLVD	92050	600	39
ENCINITAS BLVD	PACIFIC HIGHWAY	92024	1700	39
OCEANSIDE BLVD	HILL ST	92054	1500	38
J ST	BROADWAY	92010	1600	37
WASHINGTON AVE	JAMACHA RD	92021	1500	37
BALBOA AV	GENESEE AVE	92111	1500	37
NAVAJO RD	FANITA DR	92119	1500	35
LAUREL ST	SIXTH AV	92103	1500	34
L ST	FOURTH AVE	92011	1500	33
HARBOR DR	28TH ST	92113	600	33
VALLEY PARKWAY	ASH ST	92025	1600	33
PALOMAR AIRPORT RD	PASEO DEL NORTE	92009	1700	32
E LEXINGTON AVE	MOLLISON AVE	92020	1500	31
H ST	FIFTH AVE	92010	1500	31

Table 4-7 continued.

EAST – WEST	NORTH – SOUTH	ZIPCODE	PEAK HOUR BEG	PEAK HOUR USAGE
UNIVERSITY AVE	70TH ST	92041	1600	31
UNIVERSITY AVE	SPRING ST	92041	1700	31
30TH ST	NATIONAL CITY BLVD	92050	1700	30
HOWARD AVE	IDAHO ST	92104	1500	30
FLETCHER PARKWAY	JOHNSON AV	92020	1600	30
J ST	BAY BLVD WEST	92010	600	29
W MAIN ST	EL CAJON BLVD	92020	1700	29
HARBOR DR	PACIFIC HIGHWAY	92101	1700	29
FLETCHER PARKWAY	HACIENDA/WESTWIND DR	92020	1700	28
BEYER BLVD	DAIRY MART RD	92073	1600	28
LAKE MURRAY BLVD	BALTIMORE DR	92042	1500	27
H ST	ROHR ENTRANCE	92010	1500	27
WEST BOBIER DR	NORTH SANTA FE	92083	1700	26
NAPLES ST	THIRD AVE	92011	1700	26
CHASE AVE	AVOCADO BLVD	92020	1500	25
F ST	BAY BLVD WEST	92010	1600	23
EAST H ST	OTAY LAKES RD	92010	1500	23
8TH ST	EUCLID AVE	92050	1500	21
MADISON AVE	FOURTH ST	92021	1600	21
OLIVE AVE	NORTH MELROSE DR	92083	1600	20
L ST	HILLTOP DR	92010	1500	20
BONITA RD	OTAY LAKES RD	92002	1700	19
PARADISE VALLEY RD	WOODMAN ST	92139	1500	19
EAST VISTA WAY	VALE TERRACE DR	92084	1700	18
ORANGE AVE	FOURTH AVE	92011	1600	18
POWAY RD	I–15 BIKEWAY	92129	1700	18
E ORANGE AVE	HILLTOP DR	92011	1600	17
MONTECITO PL	BACHMAN PL	92103	1600	17
BROADWAY	MASSACHUSETTS AVE	92045	1600	17
IMPERIAL AVE	EUCLID AVE	92102	700	16
TELEGRAPH CANYON RD	HILLTOP DR	92010	700	15
SHADOWRIDGE DR	SOUTH MELROSE DR	92083	1700	14
LEMON AVE	BANCROFT DR	92041	1500	14
BRADLEY AVE	CUYAMACA ST	92020	600	14
RANCHO BERNARDO RD	BERNARDO CENTER DR	92128	700	10
D ST	THIRD AVE	92010	1700	10
SWEETWATER RD	PLAZA BONITA RD	92050	1500	8
TELEGRAPH CANYON RD	OTAY LAKES RD	92013	1500	8
OTAY VALLEY RD	I–805	92011	1700	4

Source: San Diego Association of Governments (1991).

Table 4-8. Total and hourly average bicycle counts, 1990 and 1987.

ZIP	EAST – WEST	NORTH – SOUTH	1990 TOTAL BIKES	1990 AVERAGE HOURLY COUNTS	1987 TOTAL BIKES	1987 AVERAGE HOURLY COUNTS	1987–1990 PERCENT CHANGE
92002	BONITA RD	OTAY LAKES RD	73	12.2	66	11.0	10.6%
92008	TAMARACK AVE	CARLSBAD BLVD	259	43.2	258	43.0	0.4%
92008	ELM AVE	CARLSBAD BLVD	293	48.9	N/A	N/A	N/A
92009	POINSETTIA LANE	CARLSBAD BLVD	178	29.7	N/A	N/A	N/A
92009	PALOMAR AIRPORT RD	PASEO DEL NORTE	93	15.5	N/A	N/A	N/A
92010	H ST	FIFTH AVE	109	18.2	121	20.2	–9.9%
92010	L ST	HILLTOP DR	71	11.9	67	11.2	6.0%
92010	D ST	THIRD AVE	30	5.0	140	23.4	–78.6%
92010	EAST H ST	OTAY LAKES RD	85	14.2	82	13.7	3.7%
92010	J ST	BAY BLVD WEST	99	16.5	116	19.4	–14.7%
92010	TELEGRAPH CANYON RD	HILLTOP DR	54	9.0	115	19.2	–53.0%
92010	F ST	BAY BLVD WEST	87	14.5	108	18.0	–19.4%
92010	H ST	ROHR ENTRANCE	86	14.4	100	16.7	–14.0%
92010	J ST	BROADWAY	158	26.4	92	15.4	71.7%
92011	OTAY VALLEY RD	I–805	12	2.0	15	2.5	–20.0%
92011	NAPLES ST	THIRD AVE	102	17.0	120	20.0	–15.0%
92011	E ORANGE AVE	HILLTOP DR	52	8.7	122	20.4	–57.4%
92011	ORANGE AVE	FOURTH AVE	62	10.4	78	13.0	–20.5%
92011	L ST	FOURTH AVE	99	16.5	188	31.4	–47.3%
92013	TELEGRAPH CANYON RD	OTAY LAKES RD	18	3.0	95	15.9	–81.1%
92020	BRADLEY AVE	CUYAMACA ST	56	9.4	79	13.2	–29.1%
92020	FLETCHER PARKWAY	JOHNSON AV	131	21.9	96	16.0	36.5%
92020	CHASE AVE	AVOCADO BLVD	100	16.7	107	17.9	–6.5%
92020	E LEXINGTON AVE	MOLLISON AVE	117	19.5	204	34.0	–42.6%
92020	FLETCHER PARKWAY	HACIENDA/WESTWIND DR	102	17.0	178	29.7	–42.7%
92020	W MAIN ST	EL CAJON BLVD	94	15.7	60	10.0	56.7%
92021	MADISON AVE	FOURTH ST	70	11.7	104	17.4	–32.7%
92021	GREENFIELD DR	MAIN ST	169	28.2	63	10.5	168.3%
92021	SECOND ST	BROADWAY	158	26.4	190	31.7	–16.8%
92021	WASHINGTON AVE	JAMACHA RD	128	21.4	88	14.7	45.5%
92024	ENCINITAS BLVD	PACIFIC HIGHWAY	148	24.7	149	24.9	–0.7%
92024	LOMAS SANTA FE DR	PACIFIC HIGHWAY	374	62.4	319	53.2	17.2%
92025	VALLEY PARKWAY	ASH ST	120	20.0	56	9.4	114.3%
92037	GILMAN DR	ROSE CANYON BIKE PATH	227	37.9	209	34.9	8.6%
92037	TORREY PINES RD	GENESEE AVE	206	34.4	330	55.0	–37.6%
92041	UNIVERSITY AVE	SPRING ST	84	14.0	91	15.2	–7.7%
92041	UNIVERSITY AVE	70TH ST	139	23.2	83	13.9	67.5%
92041	LEMON AVE	BANCROFT DR	43	7.2	N/A	N/A	N/A
92042	LAKE MURRAY BLVD	BALTIMORE DR	107	17.9	N/A	N/A	N/A
92042	AMAYA DR	SEVERIN DR	207	34.5	N/A	N/A	N/A
92045	BROADWAY	MASSACHUSETTS AVE	79	13.2	99	16.5	–20.2%
92050	8TH ST	NATIONAL CITY BLVD	124	20.7	N/A	N/A	N/A
92050	8TH ST	EUCLID AVE	67	11.2	N/A	N/A	N/A
92050	30TH ST	NATIONAL CITY BLVD	114	19.0	N/A	N/A	N/A

ZIP	EAST – WEST	NORTH – SOUTH	1990 TOTAL BIKES	1990 AVERAGE HOURLY COUNTS	1987 TOTAL BIKES	1987 AVERAGE HOURLY COUNTS	1987–1990 PERCENT CHANGE
92050	SWEETWATER RD	PLAZA BONITA RD	31	5.2	N/A	N/A	N/A
92054	OCEANSIDE BLVD	HILL ST	141	23.5	94	15.7	50.0%
92064	POWAY RD	COMMUNITY RD	139	23.2	108	18.0	28.7%
92071	MISSION GORGE RD	MAGNOLIA AVE	168	28.0	196	32.7	–14.3%
92073	BEYER BLVD	DAIRY MART RD	92	15.4	163	27.2	–43.6%
92083	SHADOWRIDGE DR	SOUTH MELROSE DR	49	8.2	N/A	N/A	N/A
92083	OLIVE AVE	NORTH MELROSE DR	75	12.5	N/A	N/A	N/A
92083	WEST BOBIER DR	NORTH SANTA FE	91	15.2	N/A	N/A	N/A
92084	EAST VISTA WAY	VALE TERRACE DR	69	11.5	N/A	N/A	N/A
92101	HARBOR DR	PACIFIC HIGHWAY	117	19.5	102	17.0	14.7%
92101	FERRY BOAT LANDING	HARBOR DR	222	37.0	116	19.4	91.4%
92102	IMPERIAL AVE	EUCLID AVE	71	11.9	68	11.4	4.4%
92103	LAUREL ST	SIXTH AV	162	27.0	152	25.4	6.6%
92103	MONTECITO PL	BACHMAN PL	58	9.7	42	7.0	38.1%
92104	HOWARD AVE	IDAHO ST	113	18.9	104	17.4	8.7%
92109	CLAIREMONT DR	EAST MISSION BAY DR	205	34.2	290	48.4	–29.3%
92111	BALBOA AV	GENESEE AVE	138	23.0	344	57.4	–59.9%
92113	HARBOR DR	28TH ST	137	22.9	146	24.4	–6.2%
92115	MONTEZUMA RD	COLLEGE AVE	712	118.7	1175	195.9	–39.4%
92115	CAMINO DEL RIO S	FAIRMOUNT AVE	195	32.5	204	34.0	–4.4%
92118	POMONA AVE	ORANGE AVE	308	51.4	171	28.5	80.1%
92119	NAVAJO RD	FANITA DR	114	19.0	119	19.9	–4.2%
92126	MIRA MESA BLVD	BLACK MOUNTAIN RD	239	39.9	265	44.2	–9.8%
92128	RANCHO BERNARDO RD	BERNARDO CENTER DR	28	4.7	49	8.2	–42.9%
92129	POWAY RD	I–15 BIKEWAY	68	11.4	41	6.9	65.9%
92139	PARADISE VALLEY RD	WOODMAN ST	66	11.0	49	8.2	34.7%
92154	PALM AVE	19TH ST	163	27.2	177	29.5	–7.9%
	ALL SITES		9,155	21.5	8,563	25.0	6.9%

Source: San Diego Association of Governments (1991).

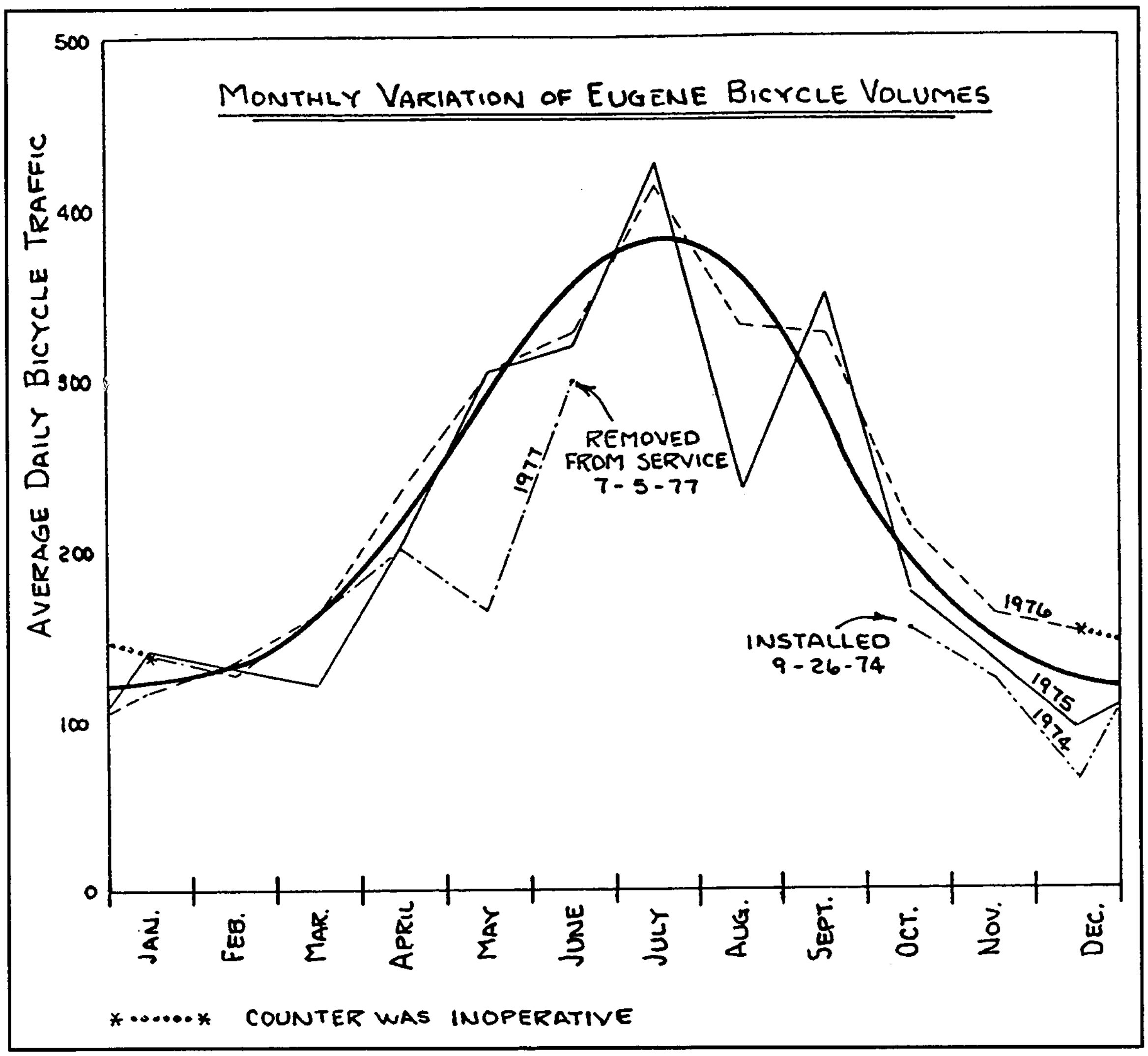
Between 1971 and 1978, bicycle traffic increased 76 percent at the same locations. The average weekday volumes for most on-street bicycle lanes ranged from 100 to 1,000 in each direction. About 600–700 cyclists rode in the bike lanes along each of two downtown streets. Over 3,000 riders used bicycle lanes near the University of Oregon and a signed route serving the hospital and downtown. Bikeways Oregon does not state how many hours were observed.

The Greenway Bridge spans the Willamette River and connects existing bicycle paths on either side of the river. According to a survey of 735 bicyclists using the Greenway Bridge and two other bridges during the summer, and a second survey of 535 bicyclists using these bridges in the winter, work trips accounted for about 30–40 percent of all weekday trips (Lipton, 1979). Another 15–20 percent of weekday trips were school trips. About half of the bicyclists surveyed crossing the Greenway Bridge would not have traveled by bicycle if the bridge had not been built. The survey findings suggest that the Greenway Bridge has eliminated about 500 automobile trips per week. Summer weekday counts on the Greenway Bridge exceeded 1,100 in 1982, and weekend counts have surpassed 2,000 (Bikeways Oregon, 1981)

Figure 4-8 shows the monthly variation in bicycle volumes on Eugene's North Bank Bicycle Trail for 1974–1977 (Regional Consultants, 1979). The volume was three times higher in the summer months than in the winter (over 300 versus 110). For 1-week periods in 1978, daily variations in bicycle volumes at three other locations in Eugene did not show a consistent pattern (Figure 4-9). For example, each location had a different peak day. Volumes on the Autzen Foot Bridge and the Ferry Street Bridge showed similar fluctuations. The volumes varied by a factor of two to three from one day to another.

Recent count data were obtained to contrast the number of riders using bike lanes on Amazon Parkway with the number using a separated path that roughly parallels the route.[2]

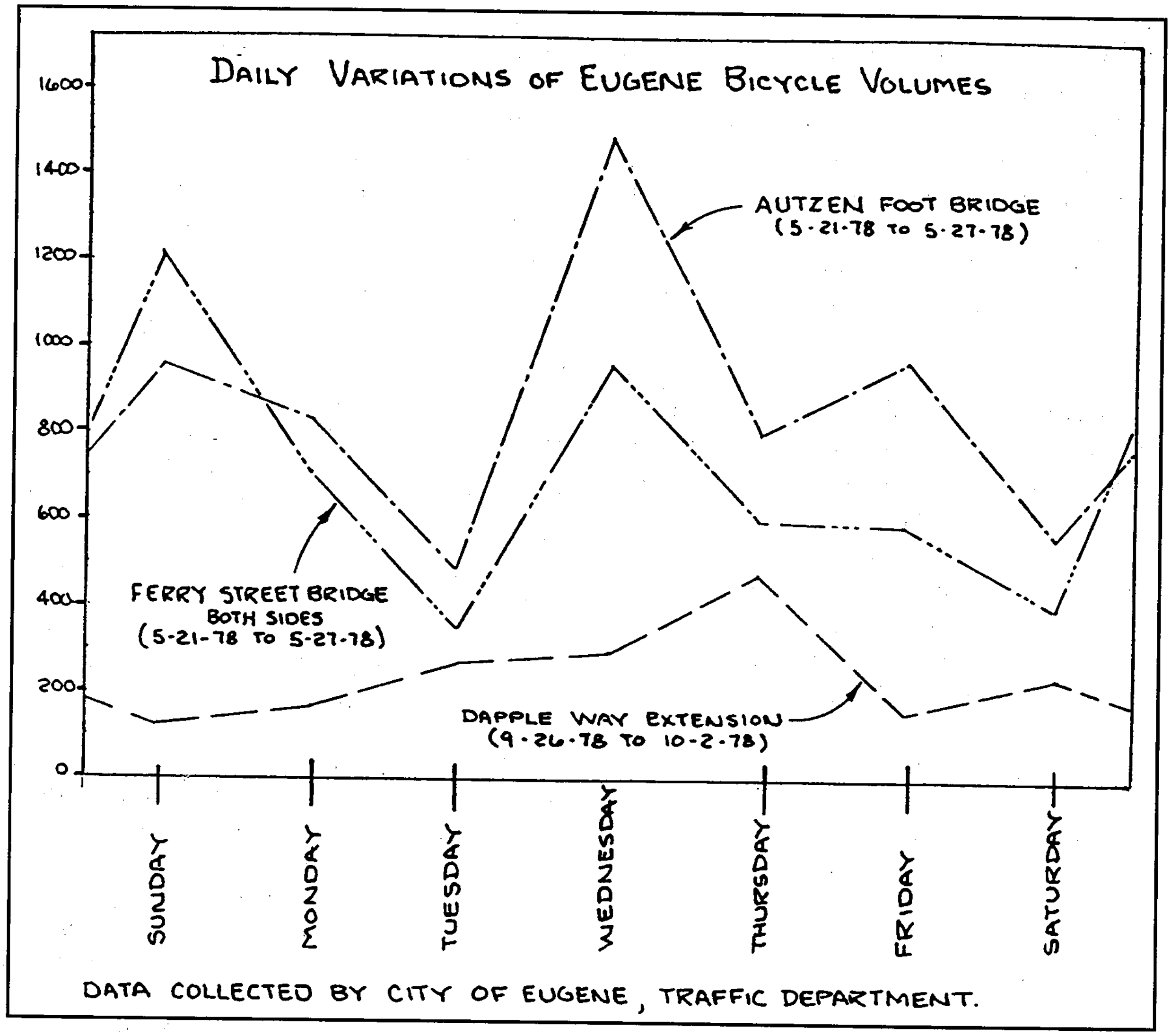
Figure 4-8. Monthly variation in Eugene bicycle volumes.



Source: Regional Consultants (1979).

[2]Personal correspondence from Diane Bishop, Bicycle/Alternative Modes Coordinator in Eugene, Oregon.

Figure 4-9. Daily variation in Eugene bicycle volumes.



Source: Regional Consultants (1979).

Both facilities are about 1 mile long. The path is 12 feet wide and is a multi-use facility. The bike lanes on each side of Amazon Parkway are 5 feet wide except for a 3.5–foot section at one intersection. Mechanical counters were used to obtain 1-week counts from noon until 11 p.m. each day on both facilities. The average number of riders per day was 450 in the bike lane and 567 in the path. Thus, the bike lane received 44 percent of the users and the bike path 56 percent.

Portland, Oregon

Along 11 bike routes in Oregon, the highest bicycle counts were recorded on the I-205 bike path at Yamhill in Portland, with 289 average daily bicycles in 1989 (State of Oregon Bikeway Program Group, 1991). One hundred seven cyclists used the Jacksonville Highway, which is a scenic highway with a shoulder bike lane, in Medford. Three-fourths of the bicyclists along the Oregon Coast Bike Route were headed south, in response to the prevailing winds. Overall helmet use in 1989 was 36 percent — eighty-two percent of touring cyclists used helmets, whereas only 28 percent of recreational and 30 percent of commuting cyclists did. Seven routes had fewer than 50 bicyclists per day.

The overall 1989 count was 861, down 4.1% from 1987.

In August 1993, the Oregon Department of Transportation set up two interview stations to interview users of the I-205 bike path (Ronkin, 1993). One station was operated for 10 hours on one day only; the other station was operated for 10 hours on each of two days.

Bicyclists comprised 598 (64 percent) of the 932 users who passed the interview stations and 217 (77 percent) of the 281 users who completed a questionnaire. Of the cyclists who completed a questionnaire, 38 percent listed travel as a trip purpose, 67 percent listed recreation, and 86 percent cited exercise. The average bicyclist rode 2.5 times per week and 12 miles on the path.

Thirty-two walkers filled out a questionnaire. Travel was a trip purpose for 19 percent, recreation was mentioned by 41 percent, and 91 percent cited exercise as a trip purpose. The average walker used the path 4.7 times per week and walked 3 miles.

New York, New York

In a 1992 traffic survey during May and June, bicycles and motor vehicles passing nine points on six avenues in midtown Manhattan, New York City, were counted for a total of 5.75 hours (Transportation Alternatives, 1990). Of all 8,035 vehicles counted, 720 (9.0%) were bicycles. The average bicycle traffic flow was 125 per hour. At Park Avenue and 34th Street during rain, bicycle flow was only 50 per hour. The flow was 252 per hour at Fifth Avenue and 34th Street on a sunny afternoon. For seven downtown locations in 1990, 585 (9.4%) out of 5,665 vehicles counted in 5 hours were bicycles (Transportation Alternatives, 1990). The average flow was 117 bicycles per hour.

The New York City Department of Transportation (1992) conducted a more comprehensive bicycle count. It found that on a typical summer weekday (7 a.m. to 7 p.m.) in 1991, 11,645 bicycles travelled in Manhattan's Central Business District. This was an increase of 6.5 percent from 1990 and a 72.5 percent increase from 1980. Sixth Avenue had the most cyclists travelling across the 50th Street Screenline, 1,186, while Eighth Avenue had the fewest, 113 (see Table 4-9). The report does not offer any explanation for the large 1990 – 91 changes observed at some locations. For example, bicycle volumes along Twelfth Avenue increased by over 2,600 percent, from 8 to 219. Eighth Avenue volumes dropped 86.9%, from 865 to 113.

Class I bicycle paths are physically separated from motor vehicle traffic and may be in their own rights-of-way or that of a street. The Brooklyn Bridge, Queensboro Bridge, and Williamsburg Bridge all have Class I bicycle paths. Through the years, more pedestrians than bicyclists have used the Brooklyn Bridge (Figure 4-10). On the other hand, bicyclists dominate on the Queensboro Bridge (Figure 4-11). Counts for the Williamsburg Bridge were not done every year (Figure 4-12).

Class II bicycle lanes are delineated by pavement markings and regulatory signs. In the Manhattan Central Business District, a northbound bicycle lane runs along the Avenue of the Americas. The southbound lane runs along Broadway from Columbus Circle south to 24th Street, then continues south along Fifth Avenue to Washington Square Park North. Since 1982, the Avenue of the Americas bike lane has had volumes ranging from 772 to 1,594 (Table 4-10). Volumes along Broadway/Fifth Avenue ranged from 400 to 954.

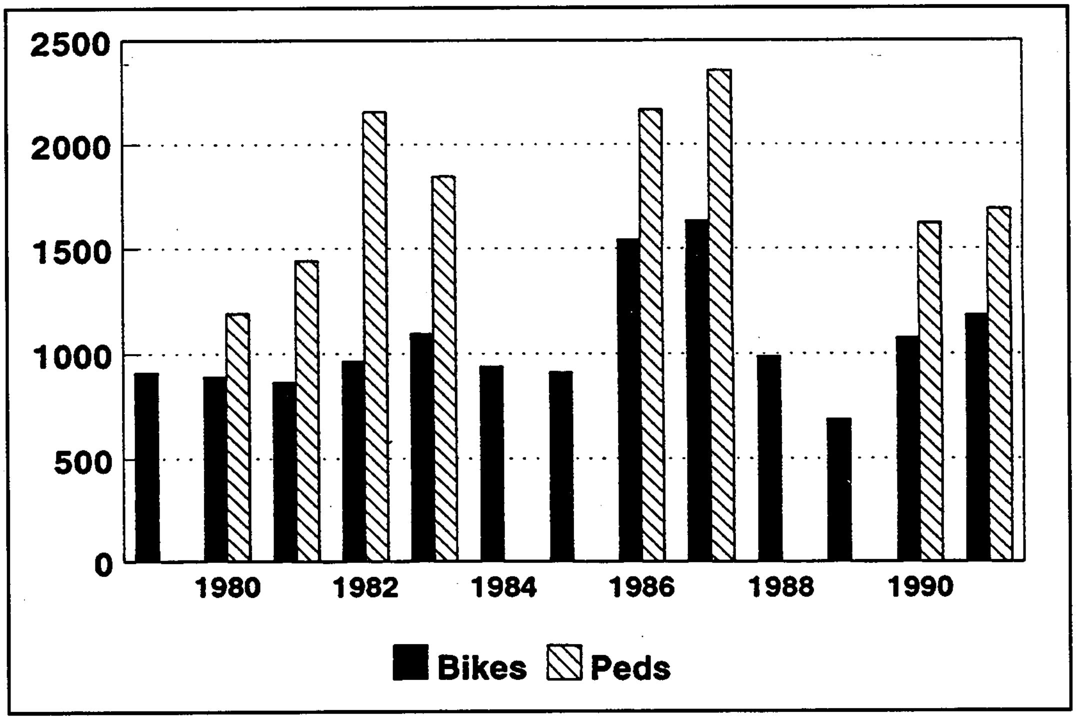
Table 4-9. Manhattan central business district bicycle volumes, 7 a.m. – 7 p.m.

Facility	1980	1985	1986	1987	1988	1989	1990	1991	1990–1991 % change
50th St. Screenline									
First Ave	220	204	302	346	347	277	250	400	60.0%
Second Ave	307	617	710	543	687	767	614	606	–1.3%
Third Ave	490	384	531	658	1,120	946	916	653	–28.7%
Lexington Ave	119	151	263	294	847	561	641	586	–8.6%
Park Ave (a)	298	478	426	361	222	932	570	1,069	87.5%
Madison Ave	434	349	272	871	1,240	1,079	850	1,026	20.7%
Fifth Ave	320	607	383	520	1,581	1,188	648	574	–11.4%
Sixth Ave (b)	648	772	968	860	1,594	1,369	1,361	1,186	–12.9%
Seventh Ave	414	533	357	568	861	657	568	892	57.0%
Eighth Ave	657	372	383	427	708	549	865	113	–86.9%
Broadway (b)	642	403	954	674	554	707	843	673	–20.2%
Ninth Ave	315	558	588	649	500	802	494	921	86.4%
Tenth Ave	119	307	353	477	476	575	465	339	–27.1%
Eleventh Ave	167	264	315	409	217	213	117	262	123.9%
Twelfth Ave	160	16	N/A	30	13	16	8	219	2637.5%
Subtotal	5,310	6,015	6,805	7,687	10,967	10,638	9,210	9,519	3.4%
Brooklyn Br. (c)	623	913	1,542	1,633	988	690	1,075	1,183	10.0%
Queensboro Br. (d)	344	759	780	436	330	423	227	602	165.2%
Williamsburg Br. (e)	146	392	420	368	282	240	248	NA	NA
Staten Island Ferry	207	231	224	327	244	202	170	341	100.6%
Subtotal	1,320	2,295	2,966	2,764	1,844	1,555	1,720	2,126	23.6%
Grand Total	6,630	8,310	9,771	10,451	12,811	12,193	10,930	11,645	6.5%

(a)Two–way roadways, all other roadways are one–way.
(b)Class II bike lane.
(c)Class I bike lane.
(d)Class I bike lane. Bikes restricted 10am–3pm 1983–1989. Shuttle van service provided 3pm–7pm. Count includes bikes on vans.
(e)Class I bike lane. (Closed 1991)

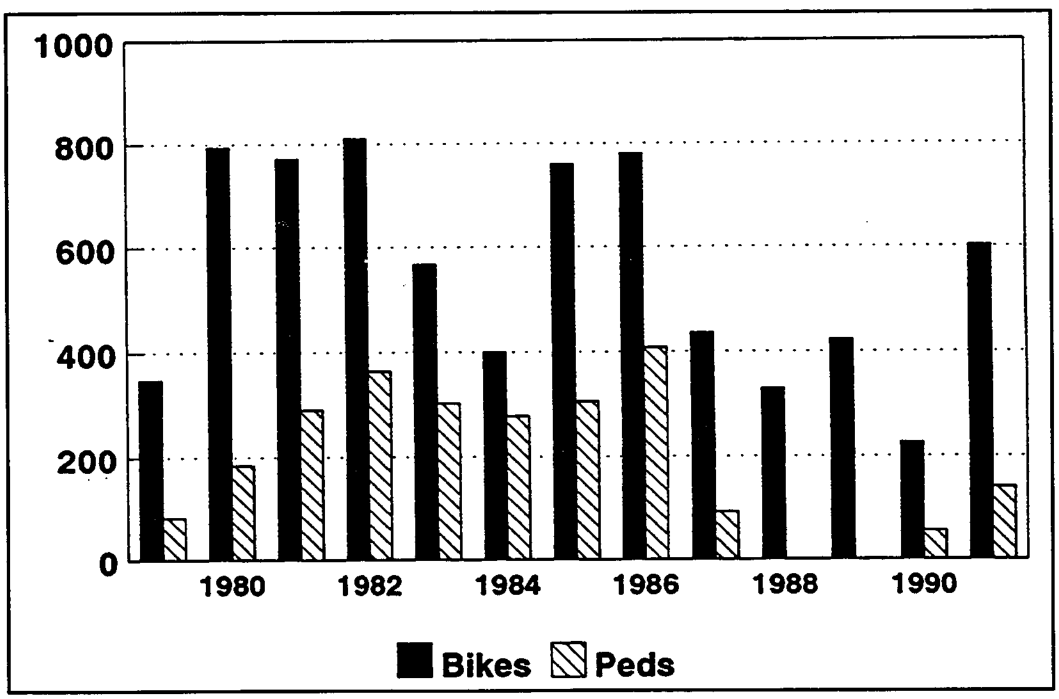
Source: New York City Department of Transportation (1992).

Figure 4-10. Brooklyn Bridge bicycle/pedestrian volumes, 7 a.m. – 7 p.m.



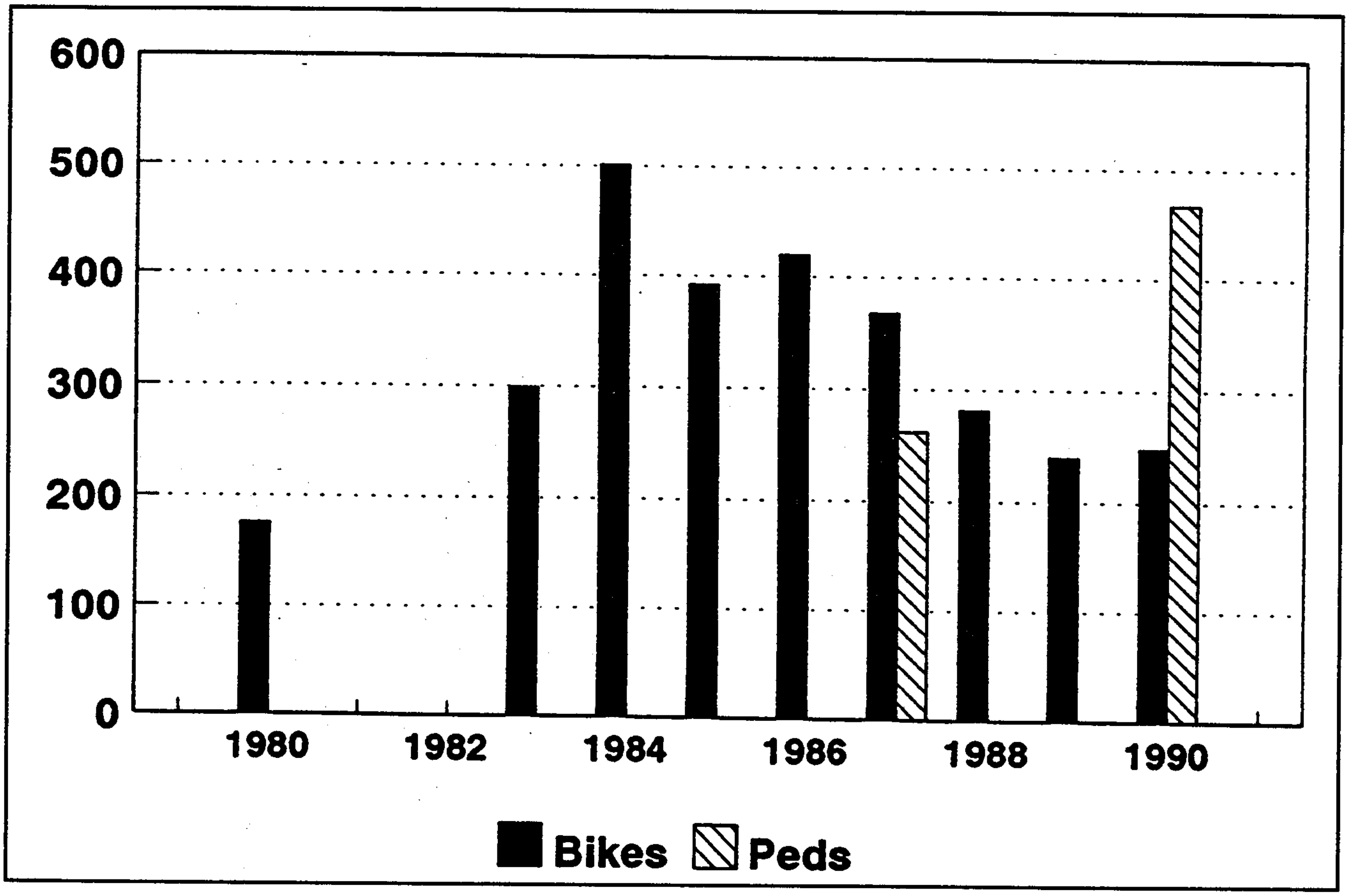
Note: Pedestrians not counted in 1979, 1984, 1985, 1988, and 1989.
Source: New York City Department of Transportation (1992).

Figure 4-11. Queensboro Bridge bicycle/pedestrian volumes, 7 a.m. – 7 p.m.



Note: Pedestrians not counted in 1988 and 1989.
Source: New York City Department of Transportation (1992).

Figure 4-12. Williamsburg Bridge bicycle/pedestrian volumes, 7 a.m. – 7 p.m.



Note: Bridge promenade closed during 1991 survey.
Source: New York City Department of Transportation (1992).

Table 4-10. Class II bike lane volumes.

Year	Avenue of the Americas	Broadway/ Fifth Avenue	Total
1978	524	N/A	524
1979	868	N/A	868
1980	648	N/A	648
1981	1,087	N/A	1,087
1982	1,030	642	1,672
1983	849	400	1,249
1984	947	796	1,743
1985	772	403	1,175
1986	968	954	1,922
1987	860	674	1,534
1988	1,594	554	2,148
1989	1,369	707	2,076
1990	1,361	843	2,204
1991	1,186	673	1,859

N/A - Surveys not conducted

Source: New York City Department of Transportation (1992).

A weekend count conducted on a 4-mile bicycle/pedestrian path in Brooklyn in September 1989 from 7 a.m. to 7 p.m. revealed 1,200 cyclists and 1,100 pedestrians.[3] When the Central Park Drives are closed to motor vehicles during the summer, 1,300 bicyclists use the drives from 10 a.m. to 3 p.m. Another 1,100 cyclists use the drives from 7 p.m. to 10 p.m.

Madison, Wisconsin

Since the 1970's, Madison has been known as a city where bicycling is both popular and an important part of the local transportation system. The 1991 bicycle transportation plan for Madison and Dane County, Wisconsin (Dane County Regional Planning Commission, et al., 1991) reports 99 miles of bicycle facilities:

Paths	20 miles
Lanes	13 miles
Mixed-traffic routes	59 miles
Sidewalk routes	7 miles

Additional facilities include many rural farm-to-market roads and county trunk highways with paved shoulders, along with two State bicycle trails.

In 1986, a random sample of over 300 bicyclists living in and around Madison showed the importance of bicycling to local transportation, in that 23 percent of the respondents replied that transportation was their primary reason for bicycling. Another 14 percent indicated that recreation and transportation were equivalent reasons for bicycling (Berchem, 1986). Table 4-11 shows the percent using bicycles for work and school trips from additional studies in the 1980's. As would be expected, bicycling is quite popular around the University of Wisconsin campus.

The Madison Department of Transportation has been monitoring bicycle use since the mid-1970's. Week-long counts are done with automatic counters at three permanent bike path count stations each month. Periodic counts are also made on city streets. Table 4-12 shows the average 24-hour weekday automatic bicycle counts on the Law and Brittingham Park Paths from 1988 through 1992. These are off-road facilities on park lands in the central business district that are close to the downtown and the university campus. Both commuter and recreational cyclists use the paths. The total length of the system is 3.7 miles, and segments are nominally 8–10 feet wide. The counts are quite stable, with warm-weather months tending to show 5–6 times as much use as in winter (see Figure 4-13). Average 24-hour weekday bicycle traffic varies by month, from 138 per day per station November – March, to 697 April – October. Between 1988 and 1992, the average daily traffic on an annual basis ranged from 414 to 552.

[3]Personal correspondence from John Benfatti, Bicycle Coordinator, New York City Department of Transportation, March 29, 1994.

Table 4-11. Bicycle use for work and school trips, Madison, Wisconsin.*

SURVEY	SURVEY POPULATION	% USING BICYCLES		DATE
1. 1980 Census	Dane County residents			April 1980
a. All County residents		2.0%		
b. Urban area residents		2.7%		
c. Madison CBD residents		5.6%		
2. Government Employee Travel Survey	Federal, state, county, city and UW employees in the urban area	5.0%		April 1980
3. WisDOT Travel-to-Work Survey	Licensed drivers residing in the Madison urban area	11.0%		July 1980*
4. UW-Madison Transportation	Students, faculty, & staff of the UW-Madison campus			Fall '83 & '89
Surveys		1983	1989	
a. Actual mode of travel to campus, in good weather				
- students living off campus		30.0%	26.3%	
- students living on campus		16.3%	18.5%	
- employees		8.3%	10.0%	
	TOTAL	22.8%	20.9%	
b. Most desired mode of travel to campus				
- students living off campus		23.5%	21.2%	
- students living on campus		18.4%	14.1%	
- employees		9.7%	6.5%	
	TOTAL	19.4%	16.3%	

Source: Berchem (1986).

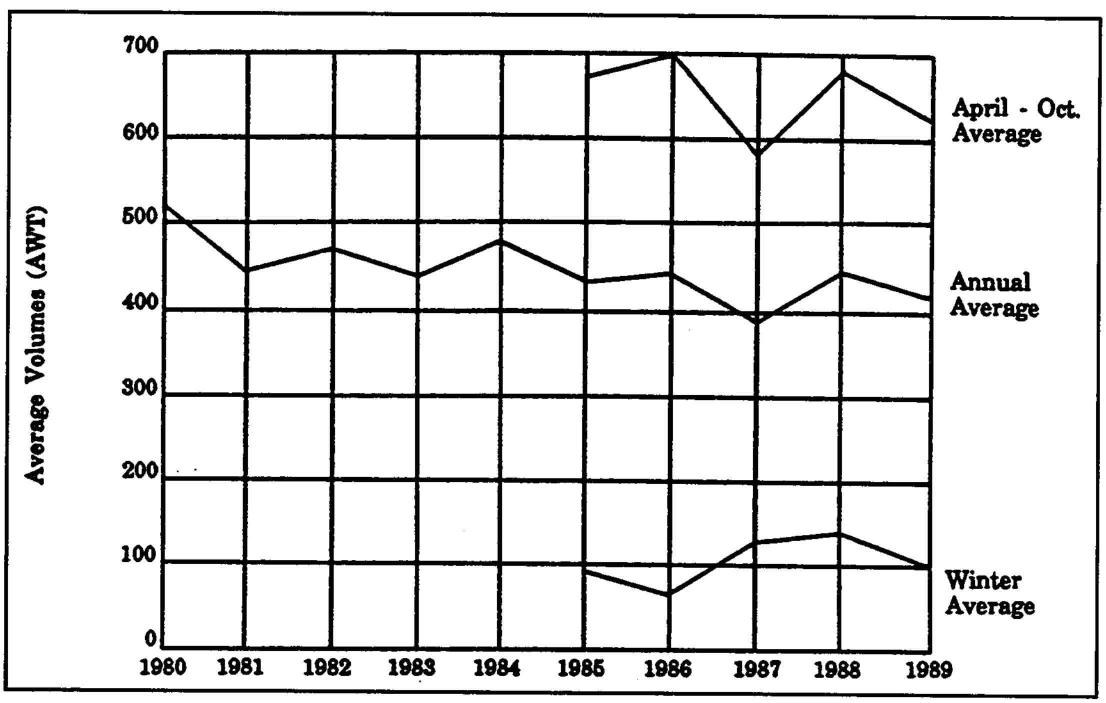
*Survey was conducted shortly after a two-month bus strike was settled. Many bus riders who switched to other modes during the strike had not yet returned to using the bus.

Table 4-12. Average 24-hour weekday bicycle traffic by month Law and Brittingham Park Paths.

Months	1988	1989	1990	1991	1992	5-Year Average
January	42	89	119	41	107	80
February	118	67	143	127	71	105
March	208	90	238	178	225	188
April	367	474	192	408	355	359
May	840	551	536	1083	601	722
June	1063	1096	785	1160	1243	1069
July	942	672	766	1152	702	847
August	778	747	924	959	678	817
September	581	546	830	763	560	656
October	335	369	524	399	409	407
November	207	176	231	217	253	217
December	91	93	90	142	101	103
Annual Total	5572	4970	5378	6629	5305	5571
Annual Avg	464	414	448	552	442	464
Apr-Oct Avg	701	637	651	846	650	697
Winter Avg	133	103	164	141	151	138

Source: Dane County Regional Planning Commission (1991).

Figure 4-13. Average weekday bike path volumes, 1980–1989.



Source: Dane County Regional Planning Commission (1991).

Table 4-13 shows weekday, Saturday, and Sunday average counts for the month of December 1993 by time and direction for the Mills and University intersection near the heart of campus. At this location, continuous bicycle counts are made using loop detectors. One-way bike lanes, both 8 feet wide, are located on each side of University. University is a one-way street, so one of the bike lanes (eastbound) is contraflow. Eastbound traffic moves toward the downtown and westbound toward campus. The December 1993 weekday average bicycle volume was 2,309. Peak hourly volume was 131 from 10–11 a.m. westbound and 122 from 3–4 p.m. eastbound. The Saturday counts were about half the weekday counts, and the Sunday counts were slightly over one-fourth of the weekday counts.

Table 4-13. Bike counts at Mills and University in Madison, Wisconsin, for December 1993.

Time	Weekday Average		Saturday Average		Sunday Average	
	Eastbound	Westbound	Eastbound	Westbound	Eastbound	Westbound
0100	9	8	10	13	5	7
0200	5	4	7	8	12	7
0300	3	4	3	7	5	6
0400	0	0	2	1	0	4
0500	1	1	2	1	0	1
0600	4	7	2	2	0	1
0700	3	13	2	8	1	3
0800	23	63	20	56	1	6
0900	38	119	11	24	5	4
1000	90	131	61	38	7	11
1100	93	106	31	37	13	14
1200	101	77	46	30	19	20
1300	98	88	58	50	22	27
1400	88	93	47	43	26	26
1500	122	101	50	63	24	28
1600	120	74	46	37	31	28
1700	103	66	58	35	26	27
1800	84	48	39	27	27	25
1900	64	35	34	29	25	17
2000	40	28	27	22	26	16
2100	32	20	21	13	15	12
2200	26	18	13	15	16	12
2300	18	13	14	15	14	11
2400	15	12	10	13	9	8
Totals	1180	1129	610	583	327	320

Source: Dane County Regional Planning Commission (1991).

Further data from November 1991 through March 1994 are provided in Table 4-14 for the University Avenue location. Volumes are quite a bit higher in warm weather months. Peak hour volumes are generally 10 to 15 percent of the total.

Table 4-14. Additional data for University Avenue in Madison, Wisconsin.

Date	Eastbound	Westbound	Total	Eastbound Peak Hour	Westbound Peak Hour
Nov. 1991	1906	1470	3376	--	--
Dec. 1991	1096	885	1981	--	--
Jan. 1992	691	637	1328	--	--
Feb. 1992	1164	1146	2310	--	--
Mar. 1992	1306	1265	2571	--	--
Apr. 1992	1174	1692	3466	176	200
May 1992	1842	1732	3574	192	171
June 1992	1639	1540	3179	189	211
July 1992	1795	1525	3420	261	217
Aug. 1992	1520	1239	2759	185	136
Sept. 1992	3510	3084	6594	380	365
Oct. 1992	3123	2804	5927	341	341
Nov. 1992	1914	1793	3707	208	229
Dec. 1992	963	961	1924	102	108
Jan. 1993	585	563	1148	68	71
Feb. 1993	1098	1024	2122	121	137
Mar. 1993	827	880	1707	94	112
Apr. 1993	1538	2096	3634	173	280
May 1993	1657	1559	3216	178	167
June 1993	1472	1449	2921	167	200
July 1993	1746	1672	3418	199	238
Aug. 1993	1376	1284	2660	163	140
Sept. 1993	3418	3068	6486	367	363
Oct. 1993	3089	2806	5895	332	339
Nov. 1993	2294	2136	4430	253	254
Dec. 1993	1180	1129	2309	122	131
Jan. 1994	345	898	1243	40	81
Feb. 1994	530	701	1231	59	84
Mar. 1994	1214	1215	2429	130	157

Source: Dane County Regional Planning Commission (1991).

Phoenix, Arizona

The City of Phoenix has been actively encouraging the use of bicycles for commuting through implementation of facilities, adding bicycle racks to all city buses, and providing showers and lockers at selected city buildings. Private industry has been asked to take similar steps.

The bicycle network totals 300 miles and includes separate paths, on-street bike routes (signed only), striped bike lanes, and wide sidewalks (Cynecki, Perry, and Frangos, 1993). There are more than 100 miles of on-street bike lanes. More than 700 miles of various facilities will eventually be included in the network.

For the designated "Bike-to-Work Day" on Wednesday, February 28, 1990, the City of Phoenix established a temporary bike route (Heffernan and Associates, 1990). Orange traffic cones were used to mark off separate bike lanes. A total of 560 unduplicated bicycle trips were recorded that day, approximately 200 more than on an average weekday. Of the 560 trips, 232 occurred between 7 and 9 a.m., 74 between 11 a.m. and 1 p.m., and 254 between 4 and 6 p.m. Eighty percent of 307 survey respondents were making work trips.

Bicycle usage volumes and riding characteristics data were obtained on nine bike lanes throughout the city in November and December of 1991 (Cynecki, Perry, and Frangos, 1993). Additional data were collected during Bike to Work Week in February of 1992. Trained observers gathered the information for 7 hours (7:00 to 9:00 a.m., 11:00 a.m. to 1:00 p.m., and 3:00 to 6:00 p.m.) at each of the nine locations. The times selected targeted commuting bicyclists. Detailed site characteristics are shown in Table 4-15. Two of the traffic signals could be actuated by bicyclists through special push buttons.

Results are shown in Table 4-16 for the November and December 1991 period. Observations were made on weekdays and in good weather conditions. Overall, 480 bicyclists were observed, or about eight per hour. Highest use was 16.7 bikes per hour (Lafayette Boulevard) during the late afternoon commute time. In general, volumes were highest in late afternoon (10.4), followed by early morning (7.2), and then midday (3.9), but this would be expected, in that bicycle commuters were being targeted.

About two-thirds of the cyclists were riding in the bike lanes in the same direction as motor vehicle traffic, while 18 percent were riding the wrong direction in the bike lanes. Another 19 percent were riding on sidewalks, which is not prohibited. Interestingly, the largest proportion of wrong-way riding occurred at Lafayette Boulevard, which formerly had a single, two-way bike lane, (perhaps bicyclists became accustomed to riding on one side of the street).

Table 4-15. Data collection site characteristics.

Bike Lane	Street Classification	ADT	Traffic Control	Date Established	Route Location
23rd Ave. at Camelback Rd.	Collector	10,000	Actuated traffic signal	February 1991	Northwest Phoenix to Central Business District
Encanto Blvd. at 7th Ave.	Collector	5,000	Actuated traffic signal	February 1991	Continuation of 23rd Ave. route.
7th St. at Broadway Rd.	Major	20,000	Fixed time traffic signal	February 1991	South Phoenix to CBD
Washington St. at 28th St.	Major	45,000	Fixed time traffic signal	October 1991	East Phoenix to CBD
Campbell Ave. at 28th St.	Collector	10,000	Fixed time traffic signal	February 1991	East Phoenix
Encanto Blvd. at 39th Ave.	Collector	5,000	Four-way STOP	February 1991	West Phoenix
Lafayette Blvd. at Arcadia Dr.	Collector	4,500	Four-way STOP	February 1991	East Phoenix
Sweetwater Ave. at 28th St.	Collector	9,000	Four-way STOP	March 1991	Northeast Phoenix
3rd Ave. at Encanto Blvd.	Collector	5,000	None	Originally established in early 1970's. Modified 8/91	Central Phoenix along CBD

Source: Cynecki, Perry, and Frangos (1993).

Table 4-16. Summary of bicycle observations (7 hours per location).

Location	Traffic Control	Number Observed	Bikes Per Hour 7-9AM	11AM-1PM	3-6PM	Bicycling Location Bike Lane	Wrong Way	On Sidewalk	Sex M	F	Age Child	Adult	Group Size One	Two or More	Helmet Use	Push Button Used (When Arrived on Red)	Obey Signal (When Arrived On Red)	Obey STOP Sign
23rd Ave at Camelback Rd	Traffic Signal	86	10.5	11.0	14.3	75%	10%	15%	85%	15%	12%	88%	86%	14%	13%	28%	95%	NA
Encanto Blvd at 7th Ave	Traffic Signal	34	4.0	1.5	7.7	94%	0%	6%	74%	26%	9%	91%	68%	32%	29%	41%	71%	NA
7th St at Broadway Rd	Traffic Signal	47	5.0	2.5	10.7	55%	17%	28%	96%	4%	19%	81%	79%	21%	6%	NA	86%	NA
Washington St at 28th St	Traffic Signal	47	7.0	3.5	8.7	58%	4%	38%	98%	2%	0%	100%	100%	0%	19%	NA	80%	NA
Campbell Ave at 28th St	Traffic Signal	60	10.0	4.0	10.7	49%	9%	42%	97%	3%	2%	98%	93%	7%	18%	NA	57%	NA
Encanto Blvd and 39th Ave	STOP Sign	58	6.0	3.0	13.3	46%	27%	27%	74%	26%	45%	55%	59%	41%	3%	NA	NA	8%
Lafayette Blvd at Arcadia	STOP Sign	90	16.0	4.0	16.7	60%	39%	1%	85%	15%	39%	61%	77%	23%	20%	NA	NA	24%
Sweetwater at 28th St	STOP Sign	29	3.5	2.0	6.0	76%	17%	7%	55%	45%	34%	66%	86%	14%	0%	NA	NA	17%
3rd Ave at Encanto Blvd (One-Way)	None	29	3.0	3.0	5.3	72%	21%	7%	72%	28%	3%	97%	86%	14%	34%	NA	NA	NA
Total		480	7.2	3.9	10.4	63%	18%	19%	84%	16%	20%	80%	81%	19%	15%	33%	80%	17%

Source: Cynecki, Perry, and Frangos (1993).

Many other results are provided in this paper, including rider demographics, helmet use, special clothing, objects carried by rider, etc. One interesting finding was that only one-third of the bicyclists who arrived on the red phase of the traffic signal used the signed and conveniently located push buttons to actuate the signal. Overall, traffic signal compliance was 80 percent, with the largest proportions of violations occurring at sites with little cross traffic. On the other hand, stop sign compliance was only 17 percent.

Bike to Work Week was held February 24–28, 1992, and two special group rides were arranged for the Tuesday of that week. Data were collected at five of the original nine sites during morning and afternoon commute times (total of 5 hours). Data collection was matched to the same day of the week as baseline observations shown in the earlier table, except for the location (23rd Avenue) where an organized group ride was held.

Results are shown in Table 4-17. Overall, 283 bicyclists were observed, or about 11 per hour. The number of cyclists per hour actually declined for Washington street at 28th Street. On the Encanto Boulevard. and 7th Street bike lanes the number of cyclists per hour increased by 15 percent or less. An increase of about 50 percent was seen on Campbell Avenue. The flow during the morning commute on 23rd Avenue (where an organized group ride was held) more than doubled, from 10.5 to 24.5. Push button use for actuating signals doubled during this period, and traffic signal compliance increased overall from 80 to 89 percent.

<u>Denver, Colorado</u>

Bicycle counts were taken at a number of locations throughout Denver August–October 1992.[4] All counts were taken between 6:00 a.m. and 9:00

[4]Personal correspondence from Robert D. Shedd, Denver.

Table 4-17. Bicycle observations during Bike to Work Week (5 hours per location).

Location	Traffic Control	Number Observed	Bikes per Hour		Bicycling Location			Sex		Age		Group Size		Helmet Use	Push Button Used (When Arrived on Red)	Obey Signal (When Arrived On Red)
			7-9AM	3-6PM	Bike Lane	Wrong Way	On Sidewalk	M	F	Child	Adult	One	Two or More			
23rd Ave at* Camelback Rd	Traffic Signal	100	24.5	17.0	67%	8%	25%	77%	23%	13%	87%	53%	47%	48%	60%	100%
Encanto Blvd at 7th Ave	Traffic Signal	30	4.5	7.0	90%	3%	7%	93%	7%	0%	100%	87%	13%	37%	59%	94%
7th St at Broadway Rd	Traffic Signal	38	5.0	9.3	57%	13%	30%	92%	8%	13%	87%	95%	5%	21%	NA	90%
Washington St at 28th St	Traffic Signal	36	5.5	8.3	43%	3%	54%	94%	6%	0%	100%	89%	11%	8%	NA	33%
Campbell Ave at 28th St	Traffic Signal	79	15.5	16.0	76%	5%	19%	80%	20%	4%	96%	78%	22%	24%	NA	71%
Total		283	11.0	11.5	68%	7%	25%	84%	16%	7%	93%	74%	26%	31%	60%	89%

*Data Collected On The Group Ride Day

Source: Cynecki, Perry, and Frangos (1993).

a.m. on days with favorable weather because the intent was to measure bicycle commuting. The counts represent a near-maximum volume rather than an average.

The Cherry Creek Path, which connects downtown Denver with residential areas to the southeast, had a peak volume of 183 bicycles. At its busiest point, the Platte Greenway Path had a volume of 80 bicycles. Much of the adjacent land is industrial, and nearby residential areas have lower densities than those near the Cherry Creek Path. The peak period volume on 16th Avenue, which has bike lanes in both directions, was 82.

Seattle, Washington

Seattle is a city noted for bicycling. The Seattle Engineering Department has been active in institutionalizing bicycling in many kinds of activities. A spot improvement program allows bicyclists to fill out a form describing problems on roadways.

While Seattle is known as a bicycle-friendly city, local bicycle program staff feel that a large part of the bicycling is done for recreation purposes. In a report for the Urban Consortium Energy Task Force (Goldsmith, draft final report, 1992–1993) that discusses the planning associated with the placement of bicycle facilities on streets within the central business district, there is recent information about bicycling facilities and trips. Based on a random telephone survey of Seattle residents in 1991, bicycle commuting is estimated at 2.5–3 percent of commute trips. Whereas the 12-mile Burke-Gilman Trail that connects to the University of Washington campus is known as one of several excellent bike paths in the area, the paths fail to constitute a true network. There are 15 miles of bicycle lanes, about 0.03 miles of bike lane for every mile of arterial. This is contrasted to Davis, California, with 0.9 miles of bike lane for every mile of arterial and a 25 percent bicycle mode split. Part of the project report discusses the effect of adding bicycle lanes to streets leading to the CBD.

A downtown bicycle count was conducted in September 1992 by volunteers from local bicycle clubs. This amounted to a cordon count taken at 29 locations during 6:30–9:00 a.m. on a dry day. A total of 1,104 bicyclists were counted over the 2.5 hours, and Table 4-18 shows key summary statistics.

The seven reporting stations shown in Table 4-19 accounted for 56 percent of the bicycle traffic. On these routes, the bicyclists accounted for 1.3 to 11.5 percent of all traffic. The 11.5 percent at the ferry terminal reflects the proportion of bicycles on ferries and is no doubt related to costs (about one-fourth the cost of transporting a car round-trip from

Table 4-18. Downtown Seattle bicycle count: Summary of results.

Total Number of Bicyclists Observed: 1104	*Males* *Females*	**80.5%** **19.5%**
Rider Wearing Helmet	*Yes* *No*	**70.6%** **29.4%**
Direction of Travel	*Toward CBD* *Away from CBD*	**78.2%** **21.8%**
Riding on Street or Sidewalk	*Street* *Sidewalk*	**85.6%** **14.4%**

Source: Goldsmith (1992–1993).

Table 4-19. Locations with highest bicycle volume counts.

Location	Number of Bicyclists Observed	Proportion of all Bicyclists Observed	Bicyclists as % of all Vehicles Passing Location
Seattle Ferry Terminal	152	13.8%	11.5%
Dexter (7th) and Bell	114	10.3%	6.9%
Pine and Boren	94	8.5%	8.3%
Elliott Bay Bike Path	92	8.3%	N/A
Stewart and Denny	69	6.3%	1.3%
Alaskan Way & Royal Broughman	55	5.0%	6.2%
Jackson & 7th S.	46	4.2%	5.0%
Totals	622	56.4%	4.6% (avg.)

Source: Goldsmith (1992–1993).

Bainbridge Island) and the fact that space for bicycles on board is plentiful. Coupled with priority over motor vehicles in loading and unloading, bicyclists realize little waiting time. The Dexter route has a 1.5–2 mile dedicated bike lane, along with moderate traffic volumes. The Elliott Bay Bike Path offers 4 miles of commuting on a separate facility, and it is assumed that more bicyclists would use this route except for a steep grade just after the path ends and congestion on other connecting streets. Nonetheless, the volume of cyclists is more than would have been expected based on census tract data, which underscores that cyclists prefer dedicated facilities. This was also apparent in the 1991 random telephone survey mentioned earlier, where approximately 74 percent felt more should be done to encourage bicycling, and of this group of respondents, about 85 percent suggested that more should be spent on facilities. Adding more facilities was also indicated as the best encouragement for more bicycle commuting.

Before describing reasons for placement of bike lanes on two separate corridors, the report digresses into a discussion of street features that characterize the degree of safety on a, street, which include:

- speed of traffic
- road width
- motorized traffic volumes
- presence of a parking lane
- presence of signalized intersections, and
- bottlenecks.

In like fashion, features of routes that are important include:

- directness
- continuity
- accessibility
- hilliness, and
- quality of alternative route(s).

A discussion on evaluating the effect of bicycle facilities is another worthwhile section of the report. The counts described earlier represented baseline data to which future counts could be compared, especially after the placement of facilities. Recommendations pertaining to consistency in counting include the following:

- choose similar dates, but be careful that weather is similar
- make time periods identical
- do not accept data strictly at face value – determine if other factors, such as a new trip generator near the facility, are associated with increases or decreases, and
- conduct a motor vehicle count during the same time frame and again analyze any change that occurs.

The report concludes with a discussion of a model that can be used to calculate energy savings and reduced emissions associated with the replacement of auto trips by bicycling trips.

Another interesting set of bicycling counts is available from the Washington State Ferries

Table 4-20. 1993 Bicycle ridership by route on the Washington State Ferry system.

Route	Full Fare	Commuter
Point Defiance -Tahlequah	4,268	540
Southworth/Vashon	436	236
Fauntleroy/Vashon	11,072	1,778
Fauntleroy/Southworth	5,660	8,800
Seattle Bremerton	19,372	3,508
Seattle Bainbridge Island	73,942	11,624
Edmonds/Kingston	8,802	1,778
Mukilteo/Clinton	6,242	2,370
Keystone/Port Townsend	5,513	1,128
Seattle/Bremerton (passenger-only)*	12	8
Seattle/Vashon (passenger-only)*	56	10
Totals	135,375	23,780

*Passenger only vessels — no motor vehicles.
Source: Personal correspondence from Marko Velikonja.

Planning Department.[5] The department tracks the number of passengers using bicycles on their ferry routes. Table 4-20 shows 1993 bicycle ridership by route by full fare versus commuters.

Full fare most likely refers to casual or infrequent users, whereas commuter refers to frequent riders using discounted books of tickets. For 1993 about 159,000 one-way trips were made by bicyclists, an average of 3,058 per week. The commuter share was about 15 percent of the total.

Count data of a different variety emerge from the replacement of a low-level drawbridge in West Seattle during 1989–1991. The low-level bridge was used by bicyclists and pedestrians to cross a canal. A high-level freeway-type bridge carried the majority of the motor vehicle traffic. The old drawbridge had little space for bicyclists or pedestrians – only a narrow sidewalk that both tended to use. While the drawbridge was being replaced, a shuttle van was used to transport bicyclists and pedestrians over the high-level bridge, and daily counts of passengers and bicycles were made (Table 4-21). The table and accompanying Figures 4-14 and 4-15 provide a good picture of the seasonality of use associated with non-motorized modes. The average bikes per day ranged from 68.3 in March of 1990 to 104.0 in August of 1989. Bicycle use of the van was higher than originally anticipated, in that street connections to the old drawbridge were not generally favorable to bicyclists.

Gainesville, Florida

The city of Gainesville has records of bicycle counts taken since 1982. Counts are routinely done by the Metropolitan Transportation Planning Organization (MTPO), and the latest report of the counts ("1993 Bicycle Usage Trends Program") presents 1993 data, along with other data from 1982–1993 at permanent counting locations (North Central Florida Regional Planning Council, 1994). In 1982 there were 32 count locations, and the number of locations has varied since then. Nine locations were counted from 1989–1991, and in 1992 two other locations were added. Much of the data in the report pertains to the 11 permanent counting locations.

Data for the current report were collected from September to December 1993. Weekday counts were utilized except for holidays; days in which public schools, the community college, or the University of Florida were not in session; and days of bad weather. At each location, counts were obtained in 15-minute intervals from 7 a.m. to 7 p.m. A standard form was used to record counts on all legs of the count location/ intersection. Besides directional movements, other data items included whether traveling on- or off-street, with or against traffic, wearing a helmet, and using lights at night.

Table 4-22 shows bicycle volume counts for 12 hours for the 11 permanent locations from 1990–1993. For all locations combined, the total counts increased 12.6 percent between 1992 and 1993. In general, more bicyclists were observed at locations near the University of Florida (locations 23, 28, 31, and 37). These four locations accounted for 72 percent of the total, and all have bicycle facilities that feed into the intersection:

- Location 23 — 4 foot designated bike lane, wide curb lanes, and sidewalks
- Location 28 — wide curb lanes and sidewalks
- Location 31 — 4 foot designated bike lanes
- Location 37 — wide curb lanes and sidewalks

The remaining count locations have a mix of facilities[6] available:

- Location 13 — undesignated 4 foot bike lane and off-street facility with legal status of a sidewalk
- Location 15 — designated 5 foot bike lanes and sidewalks

[5]Personal correspondence from Marko Velikonja of the Washington State Ferries Planning Department.

[6]Personal correspondence from Linda Dixon, City of Gainesville Bicycle/Pedestrian Coordinator.

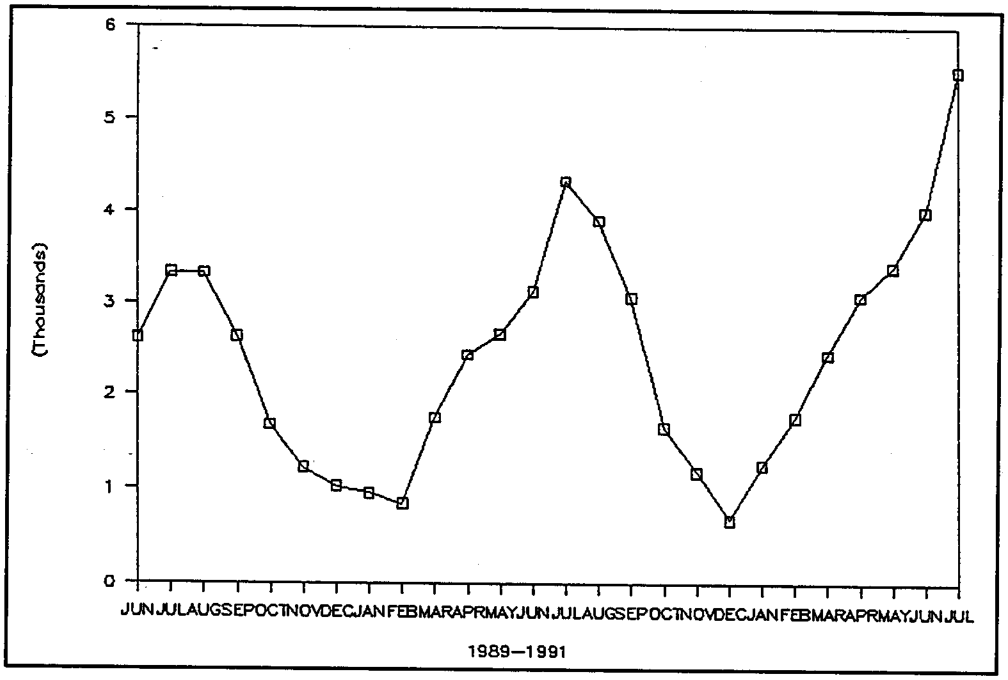
Table 4-21. Bicyclists and pedestrians transported by shuttle van, West Seattle Freeway.

MONTH	YEAR	DAYS PER MONTH	EASTBOUND PASSENGERS	EASTBOUND BICYCLES	WESTBOUND PASSENGERS	WESTBOUND BICYCLES	BIKES PER MONTH	RUNNING TOTAL	TOTAL OPERATING DAYS	AVERAGE BIKES PER DAY
JUNE	1989	30	1,520	1,360	1,387	1,255	2,615	2,615	30	87.2
JULY	1989	30	1,763	1,674	1,738	1,651	3,325	5,940	60	99.0
AUG	1989	29	1,763	1,672	1,747	1,646	3,318	9,258	89	104.0
SEPT	1989	27	1,379	1,322	1,386	1,311	2,633	11,891	116	102.5
OCT	1989	29	922	931	800	752	1,683	13,574	145	93.6
NOV	1989	28	797	678	681	554	1,232	14,806	173	85.6
DEC	1989	30	771	541	664	488	1,029	15,835	203	78.0
JAN	1990	30	792	548	631	410	958	16,793	233	72.1
FEB	1990	25	675	417	626	427	844	17,637	258	68.4
MAR	1990	26	1,171	908	1,014	856	1,764	19,401	284	68.3
APR	1990	30	1,382	1,187	1,420	1,255	2,442	21,843	314	69.6
MAY	1990	30	1,637	1,399	1,451	1,266	2,665	24,508	344	71.2
JUNE	1990	30	1,868	1,565	1,792	1,559	3,124	27,632	374	73.9
JULY	1990	31	2,556	2,141	2,502	2,197	4,338	31,970	405	78.9
AUG	1990	30	2,191	1,923	2,233	1,980	3,903	35,873	435	82.5
SEPT	1990	28	1,787	1,533	1,721	1,531	3,064	38,937	463	84.1
OCT	1990	30	1,116	891	990	771	1,662	40,599	493	82.3
NOV	1990	30	865	622	739	564	1,186	41,785	523	79.9
DEC	1990	30	664	352	578	326	678	42,463	553	76.8
JAN	1991	28	883	679	779	580	1,259	43,722	581	75.3
FEB	1991	28	1,097	896	1,049	871	1,767	45,489	609	74.7
MAR	1991	31	1,474	1,224	1,444	1,214	2,438	47,927	640	74.9
APR	1991	30	1,786	1,569	1,683	1,504	3,073	51,000	670	76.1
MAY	1991	31	1,963	1,719	1,904	1,672	3,391	54,391	701	77.6
JUNE	1991	30	2,293	1,993	2,276	2,015	4,008	58,399	731	79.9
JULY	1991	31	3,031	2,768	2,975	2,764	5,532	63,931	762	83.9

SHUTTLE

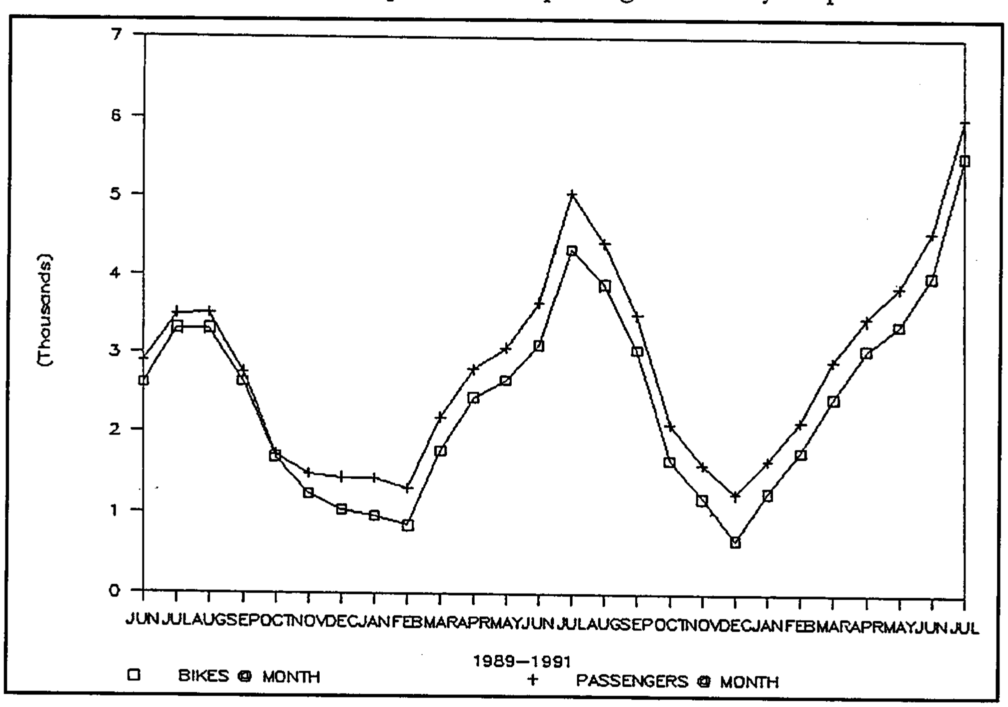
Source: Personal correspondence from Marko Velikonja, Washington State Ferries Planning Department.

Figure 4-14. Shuttle van report — total bicycles per month.



Source: Personal correspondence from Marko Velikonja.

Figure 4-15. Shuttle van report — total passengers and bicycles per month.



Source: Personal correspondence from Marko Velikonja.

- Location 22 — undesignated 3.5 foot bike lanes, designated 4 foot bike lanes, and sidewalks
- Location 25 — undesignated 3.5 foot bike lanes, off-street facility with legal status of a sidewalk, and sidewalks
- Location 32 — sidewalks
- Location 40 — wide curb lanes and sidewalks
- Location 54 — off-street facility with legal status of a sidewalk

Table 4-23 shows bicycle volumes by time of day. Counts were lowest from 7–8 a.m. and 6–7 p.m. and highest at 8–9 a.m. and 5–6 p.m. The volumes were actually quite consistent from 8 a.m. to 6 p.m. This pattern likely results from work and school commuting.

Table 4-22. Bicycle volume by count location, Gainesville urbanized area, 1993 (weekday counts, 7:00 a.m. – 7:00 p.m.).

COUNT LOCATION NUMBER[a]	INTERSECTION	1990 BICYCLE VOLUME	1991 BICYCLE VOLUME	1992 BICYCLE VOLUME	1993 BICYCLE VOLUME	1993 PERCENT OF TOTAL
13	N.W. 34th Street and N.W. 39th Avenue	156	176	187	143	1.0
15	S. Main Street and S.W. 2nd Avenue	581	667	668	529	5.0
22	S.W. 34th Street and S.W. 20th Avenue	957	732	675	631	6.0
23	S.W. 13th Street and S.W. 16th Avenue	897	1,621	1,493	785	8.0
25	S.W. 34th Street and S.W. 2nd Avenue	767	929	697	819	8.0
28	W. 13th Street and W. University Avenue	1,886	2,112	1,504	2,290	23.0
31	S.W. 23rd Terrace and Archer Road	1,121	1,144	1,134	1,612	16.0
32	N.W. 34th Street and N.W. 8th Avenue	N/A	N/A	297	410	4.0
37	W. 17th Street and W. University Avenue	2,305	2,281	1,508	2,594	26.0
40	E. 9th Street and E. University Avenue	225	314	224	233	2.0
54	N.W. 23rd Avenue and N.W. 83rd Street	N/A	N/A	601	70	1.0
	TOTAL	8,895	9,976	8,988	10,116	100.0

[a] Each location in the program is assigned a number. See Illustration I for the location of each count station.

N/A=Counts were not taken at this location for this year.

Note: It should be noted that counts were taken during and immediately following the five student homicides in the Fall of 1990. During this tense period in Gainesville, students were advised to travel in groups and avoid after dark travel. This may explain the decrease in bicycle volume observed in the Fall of 1990. Incidentally, the decrease in in bicycle volume is noticed primarily at locations adjacent to the University of Florida campus and not other locations in Gainesville

Source: North Central Florida Regional Planning Council (1994).

Table 4-23. Total bicycle volume by time, 1993.

TIME INTERVAL	NUMBER OF BICYCLES	PERCENT OF TOTAL
7:00 - 8:00 A.M.	572	5.7
8:00 - 9:00 A.M.	943	9.3
9:00 - 10:00 A.M.	889	8.8
10:00 - 11:00 A.M.	863	8.5
11:00 - 12:00 Noon	788	7.8
12:00 - 1:00 P.M.	928	9.2
1:00 - 2:00 P.M.	844	8.3
2:00 - 3:00 P.M.	929	9.2
3:00 - 4:00 P.M.	914	9.0
4:00 - 5:00 P.M.	850	8.4
5:00 - 6:00 P.M.	969	9.6
6:00 - 7:00 P.M.	627	6.2
TOTAL	10,116	100.0

Source: North Central Florida Regional Planning Council (1994).

Table 4-24. Bicycle volume trends, 1982–1993.

		YEAR											
NUMBER	INTERSECTION	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
13	NW 34th Street and NW 39th Avenue	93	105	130	162	111	84	129	157	156	176	187	143
15	S. Main Street and SW 2nd Avenue	804	N/A	669	630	529	560	518	566	581	667	668	529
22	SW 34th Street and SW 20th Avenue	795	1,312	1,251	1,053	893	626	731	812	957	732	675	631
23	SW 13th Street and SW 16th Avenue	760	1,478	1,824	2,026	1,231	1,369	1,384	1,564	897	1,621	1,493	785
25	SW 34th Street and SW 2nd Avenue	594	N/A	1,066	1,296	853	867	760	868	767	929	697	819
28	W 13th Street and W University Avenue	2,085	N/A	2,479	3,188	2,873	2,327	1,944	2,462	1,886	2,112	1,504	2,290
31	SW 23rd Terrace and Archer Road	956	N/A	1,268	1,368	1,191	732	1,034	1,121	1,121	1,144	1,134	1,612
32	NW 34th Street and NW 8th Avenue	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	297	410
37	W 17th Street and W University Avenue	N/A	3,714	3,139	3,365	3,646	2,876	2,484	2,768	2,305	2,281	1,508	2,594
40	E 9th Street and E University Avenue	N/A	N/A	247	225	247	165	224	259	225	314	224	233
54	NW 23rd Avenue and 83rd Street	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	601	70
	TOTAL	6,087[a]	6,609[a]	12,073	13,313	11,574	9,606	9,208	10,577	8,895	9,976	8,988	10,116

[a] Figure includes data for locations where available.

N/A = Counts were not taken at this location for this year.

Note: It should be noted that 1990 counts were taken during and immediately following the five student homicides in the Fall of 1990. During this tense period in Gainesville, students were advised to travel in groups and avoid after dark travel. This may explain the decrease in bicycle volume observed in the Fall of 1990. Incidentally, the decrease in bicycle volume is noticed primarily at locations adjacent to the University of Florida campus and not other locations in Gainesville.

Source: North Central Florida Regional Planning Council (1994).

Table 4-24 shows trend counts from 1982 to 1993. Peak volumes occurred from 1984–1986. The largest increase over the 11-year period (68.6 percent) occurred at Location 31. The overall decrease in 1990 may be directly related to five student homicides. Location 28, which is near the university, had the most pronounced decline (23.4 percent).

Table 4-25 shows the percent of bikes on-road for each location. On-road means using a facility such as a bike lane, wide curb lane, or paved shoulder. Off-road cyclists were generally using sidewalks or bike paths. Location 15 with designated 5-foot bicycle lanes contained the highest percent of on-road bicycles (77 percent). For all locations combined, 30 percent of the bicycles were on road.

Table 4-25. Percent of bicycles on road by location.

Location	Percent of Bicycles on Road
13	58
15	77
22	15
23	58
25	11
28	13
31	13
32	16
37	46
40	31
54	54

Source: Personal correspondence from Linda Dixon.

Fort Myers/Lee County, Florida

The city of Fort Myers (population 44,000) lies within Lee County (population 335,000) in Florida. Within the city and county, soft rubber tubes and automated traffic counters have been used to obtain 1-week counts of bicycles on various facilities. The most recent data were collected between May and October of 1991.[7] Counts were provided for a separated bike path, a bike lane, a paved shoulder, and a sidewalk. Table 4-26 show some summaries. The busiest of these facilities was the separated bike path.

[7]Personal correspondence from Mohsen Salehi, Bicycle/Pedestrian Planning Coordinator for the Fort Myers/Lee County area.

Table 4-26. Bicycle facility counts from Fort Myers, Florida.

Facility Type	Facility Surface Type	Road Type	Average Daily Bicycles	A.M. Peak Hour Volume	P.M. Peak Hour Volume	Average Weekly Bicycles	Average Daily (Auto) Traffic
Bike path	Asphalt	4-lane, divided	87	78	28	588	23,885
Bike lane	Asphalt	2-lane, divided	37	11	12	301	9,455 (approx)
Paved shoulder	Asphalt	2-lane	33	9	10	233	4,024
Sidewalk	Concrete	2-lane	63	13	17	444	20,786

Source: Personal correspondence from Mohsen Salehi.

Fort Lauderdale, Florida

A bicycle lane study was performed by the Florida Department of Transportation (FDOT) in Fort Lauderdale during the first half of 1992 and in April 1993 (Florida Department of Transportation, 1993). At issue was the placement of a non-standard, signed and designated 3-foot (0.91 m) bicycle lane along a 2–3 mile beachfront area along State Road A-1-A. Initially the FDOT had proposed major reconstruction for the section, including a median, landscaping, widened sidewalks, tree plantings, etc. Bicycles were to be accommodated on 14-foot outside curb lanes. However, the City of Fort Lauderdale petitioned the FDOT to designate a temporary 3-foot bike lane (4-foot lane is standard according to FDOT) to provide a more attractive environment for pedestrians and bicyclists. The FDOT asked the Broward County Bicycle Advisory Committee (BCBAC) for their opinion, and the BCBAC agreed to placement of the non-standard facility subject to two provisions: (1) that local police enforce wrong-way riding, and (2) that bicycle safety literature be made available to the public. The BCBAC also recommended a field study to elicit public opinion about the facility.

A questionnaire was administered to roadway users (including pedestrians, bicyclists, motorists, and skaters) on Sunday, April 4, 1993, and Wednesday, April 7, 1993. Videotaping was done before, during, and after construction of the bike lane. Police reports from April 1990 to March 1993 were obtained from the City of Fort Lauderdale. A before-after conflict study was also conducted.

The conflict study led to the collection of some usage data on the bike facility and the adjacent sidewalks.[8] Before bike lane data were collected on Saturday, February 15, 1992, at two separate locations. Both directions of travel were examined separately for 15-minute periods. Similar data, with the new design in place, were collected on Saturday, May 2, 1992. The volume data are shown in Table 4-27.

If the 15-minute counts could be extrapolated to 1 hour, then the peak pedestrian volume would be 488 per hour southbound on Bayshore in the before period and 236 per hour southbound on Terramar with the bike lane in place. The peak bicycle volume would be 60 per hour northbound on Bayshore before the facility was in place and 48 per hour northbound on Terramar in the after period. Note that 40–45 percent of the bicycles were on the sidewalk both before and after the bike lane was designated. A problem with these counts is that the before data were collected during the busy tourist

[8]Personal correspondence from Beatriz Caicedo, project manager of the State Road A-1-A Bicycle Study, of the Florida Department of Transportation, Fort Lauderdale office, District IV.

season, while the after data were out of season. Thus, the lower volumes recorded after the bike lane was constructed probably reflect the lower number of tourists and not a negative impact caused by the bike lane itself.

Table 4-27. Volume data for pedestrians and bicyclists from the State Road A-1-A bicycle lane study.

Before Bike Lane	Pedestrians	Bicycles In Street	Bicycles On Sidewalk	Total Bikes
NB Bayshore 1:00 p.m.	78	15	19	34
SB Bayshore 1:40 p.m.	122	10	0	10
NB Terramar 2:35 p.m.	63	7	10	17
SB Terramar 3:05 p.m.	81	7	0	7
NB Total	141	22	29	51
SB Total	203	17	0	17
Total--Both Directions	344	39	29	68
After Bike Lane	**Pedestrians**	**Bicycles In Street**	**Bicycles On Sidewalk**	**Total Bikes**
NB Bayshore 1:00 p.m.	44	8	14	22
SB Bayshore 1:30 p.m.	55	2	3	5
NB Terramar 3:05 p.m.	48	12	6	18
SB Terramar 3:33 p.m.	59	6	0	6
NB Total	92	20	20	40
SB Total	114	8	3	11
Total--Both Directions	206	28	23	51

Source: Personal correspondence from Beatriz Caicedo.

Tallahassee, Florida

In a paper prepared for a conference entitled "Bicycle Safety, Planning, and Design for Chinese Cities," Burden, Wallwork, and Guttenplan (1994) discuss utility roundabouts versus standard intersections. A modern roundabout is defined in the following way:

> A modern roundabout is different from a rotary, circle, or regular roundabout. The modern roundabout always requires entering traffic to yield the right of way, always controls the speed of the entering vehicle, and always uses a small interior island and splitter islands, to create these operations.

The authors state that 2,700 motor vehicles per hour can be accommodated in a single lane roundabout and 6,000 motor vehicles per hour in a 3-lane roundabout. In regard to bicycle capacity, a roundabout intersection at Hutchinson and California Streets on the University of California, Davis Campus has projected flow rates of 9,000 bicycles per hour. This is a derived rate based on 12-minute counts during class breaks projected to 1 hour. The authors used videotape of the intersection to estimate that approximately 20 percent more bicycles could be accommodated, yielding a capacity flow of 11,000 bicycles per hour for the intersection of the two 8-meter wide streets. The rate accounts for some motor vehicles (reduced during class changes) and pedestrians (peak volume during class changes) sharing the roundabout.

Monroe County, Florida

Monroe County, located in extreme southern Florida, includes portions of Everglades National Part as well as the Florida Keys. In April 1994, bicycle counts were taken at three locations along U.S. Route 1 and five locations within the city of Key West.[9]

The types of facilities were:

- Paved shoulder (US-1 at MM 105 and MM 92)
- 8–foot asphalt path (US-1 at MM 52)
- 8–foot concrete path (both Roosevelt locations)
- Local city streets (other three sites)

Weekday counts were done for seven hours (Monday at US-1 at MM 92, Friday at the other 7 locations), while Saturday and Sunday counts were done for 6 hours each. Weekday bicycle volumes ranged from 40 to 640, with a total of 2,716 for the eight locations (Table 4-28 and Figure 4-16). Sunday was nearly as busy (2,633), and 2,115 bicycles were counted on Saturday. On Friday, one location had its peak hourly count total (23) at 9:30 a.m.

Table 4-28. Monroe County, Florida, bicycle traffic counts, April 1994.

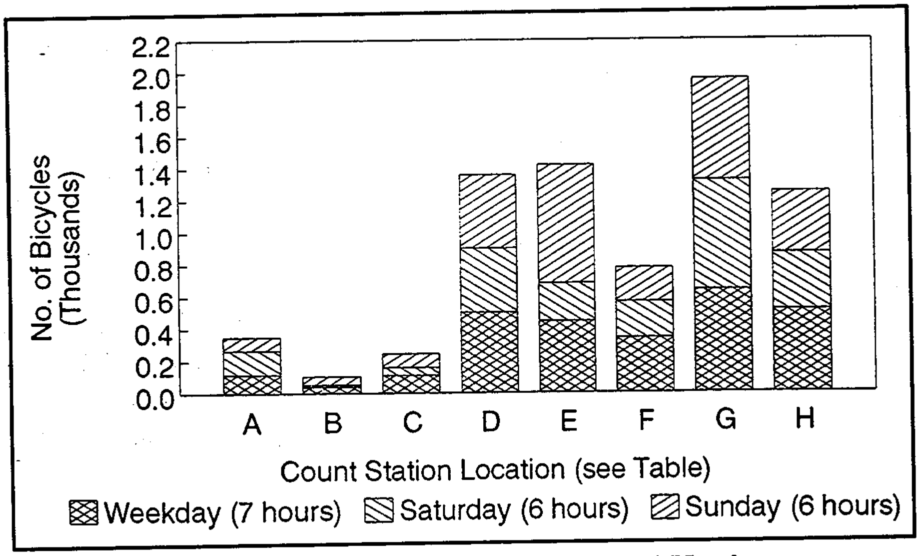
LOCATION	Weekday (7 hour)	Saturday (6 hour)	Sunday (6 hour)	TOTAL
A US–1 @ MM 103	117	151	83	351
B US–1 @ MM 92	40	14	52	106
C US–1 @ MM 52	111	50	87	248
D N Roosevelt @ Hilton Haven Dr	502	402	455	1359
E S Roosevelt e.o. Bertha St	447	238	736	1421
F Truman Ave s.o. Simonton St	344	224	211	779
G Duval St s.o. Southard St	640	681	631	1952
H Whitehead St s.o. Eaton St	515	355	378	1248
TOTAL:	2716	2115	2633	7464

= rain/overcast weather

Source: Personal correspondence from David Henderson, State of Florida Department of Transportation.

[9] Personal correspondence from David Henderson, State of Florida Department of Transportation.

Figure 4-16. Monroe County, Florida, bicycle traffic counts, April 1994.



Source: Personal correspondence from David Henderson.

The other peak hourly counts (14 to 141) were recorded at 10:30, 12:30, and 1:30. The peak hours and high weekend volumes suggest that most bicycling is done for recreation and not commuting.

Chapel Hill, North Carolina

Chapel Hill, North Carolina (population 39,000) is home to the University of North Carolina. In October 1993 a 12-hour count (7 a.m. – 7 p.m.; both directions) was conducted on Airport Road, a 5-lane principal arterial with average daily traffic of approximately 23,000 vehicles. Airport Road has sidewalks on both sides, and the 4-foot sidewalk on the west side of the road is designated as a bicycle path. For this particular count, the sidewalks yielded 780 walking and 591 bicycling trips.[10]

The Netherlands

In medium-sized Dutch cities (50,000 to 200,000 inhabitants), the modal split for bicycles for total internal vehicle trips during rush hours is 40 percent (Botma and Papendrecht, 1991). The authors note that, despite the importance of bicycling as a means of transportation, little research into the geometric design of bicycle facilities has been undertaken.

The authors collected data on heavily used bicycle paths at four locations in urban areas and one location in a rural area. One path in an urban area had a width of only 180 cm. The other three urban paths had widths of 240, 250, and 270 cm. The rural path had a width of 300 cm and was part of a long-distance tour route. Bicycle counts were carried out over a 3-hour period that included a rush hour. The narrow path had 1,199 bicycles during the 3-hour period. Bicycle volumes on the urban paths were 1,693; 1,671; and 1,481. These counts suggest daily bicycle volumes that are higher than volumes observed on most streets and trails in the United States. The rural path had 8,860 bicycles. Average speeds were 14 km/hour on the urban paths and 25 km/hour on the rural path.

[10]Personal correspondence from David Bonk, Town of Chapel Hill Planning Department.

CHAPTER 5. PEDESTRIAN TRIP COUNTS

Introduction

Similar to the preceding chapter about bicycle trip counts, data associated with pedestrian trips were also obtained from a variety of sources. Geographical headings are once again typically used to provide orientation.

Site Descriptions

United States Cities

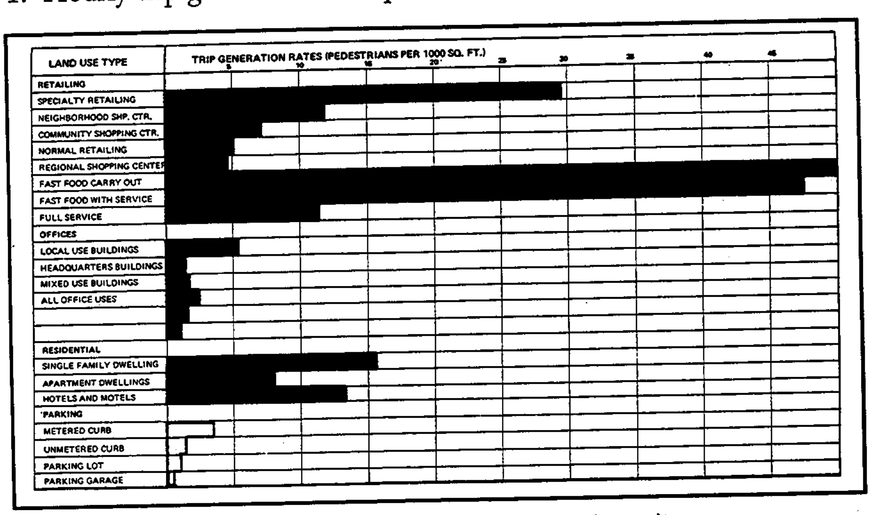
Figure 5-1 depicts hourly trip generation rates for various land use types (Kagan, Scott, and Avin, 1978). These rates were derived from pedestrian trip counts taken at 215 sites in unspecified cities.

Among retail outlets, specialty stores generated an average 29.6 pedestrians per hour per 93 m^2 (1,000 $ft.^2$). Trip rates ranged from 3.1 for a men's clothing store to 54.8 for a bookstore. More diversified retail uses, such as regional shopping centers, had much lower trip generation rates (4.7 per hour per 93 m^2 (1,000 $ft.^2$)). Trip generation was very high for fast food, carry-out, with 128.4 trips per hour per 93 m^2 (1,000 $ft.^2$), and for fast food with service (47.6).

Office buildings that were less than 18,600 m^2 (200,000 $ft.^2$) had the highest generation. Local use offices generated 5.4 pedestrians per hour per 93 m^2 (1,000 $ft.^2$). Of these, the post office and the motor vehicle department both had 14.6 person trips per hour. An average of 1.2 trips per hour per 93 m^2 (1,000 $ft.^2$) was observed for headquarters buildings. Headquarters functions such as banking and insurance administration tend not to attract the general public. Also, these buildings are often larger and employees are more likely to find restaurants and retail services within the building, thus reducing employee trips.

The residential trips are shown by dwelling unit over a 24-hour period. A single-family dwelling unit generated 15.4 trips, compared to 8.1 trips for an apartment unit and 13.4 trips per occupied hotel or motel room. For both single-family dwellings and apartments, the trip generation rate per resident was 4.6.

Figure 5-1. Hourly trip generation rates per 1,000 ft^2 ($93m^2$) for different land use types.



Source: Kagan, Scott, and Avin (1978).

Pedestrian trip generation data for parking facilities were compiled separately (RTKL Associates, Inc., 1976). Depending on trip purpose, vehicle occupancy rates varied from 1.2 to 2.1. The trip rate per parking space was twice the turnover rate for spaces multiplied by the vehicle occupancy. The hourly trip rate for metered curb spaces ranged from 2.1 to 3.6. As vehicles usually remain parked for longer periods of time in parking garages than in curb spaces, a parking garage space generated only 0.4 to 0.6 trips per hour.

Chapter 13 for the 1985 version of the Highway Capacity Manual (Transportation Research Board 1985) has information about pedestrian flow as it pertains to the analysis of pedestrian facilities. Table 5-1 depicts pedestrian volumes observed at selected locations in several cities. The average flow rates over a full hour ranged from 14 pedestrians/minute along F Street NW in Washington, D.C., to 342 pedestrians/minute at the intersection of State Street and Madison in Chicago. Comparisons are difficult because of varying times of day, year, and walkway widths. The value for F Street, NW, was taken during an unspecified time one afternoon in 1981, along a 15.0-foot wide sidewalk. The count for State/Madison was taken during an unspecified time of the day in 1929, along a 25.0-foot wide sidewalk. Additional pedestrian trip counts taken in Washington, D.C., New York, and Chicago were found in the sources mentioned in this chapter.

Washington, D.C

Davis, et al. (1987) describe and evaluate the state-of-the-practice in measuring pedestrian volumes, through manual counts, mechanical counting devices, and mathematical models. Next the authors investigate two sampling-based methods for predicting pedestrian volumes using pedestrian volume data from Washington, D.C. Additional research is suggested to test the models' validity and reliability.

In July 1986, the authors obtained manual pedestrian counts at eight intersections and six midblock locations in Washington, D.C. Counts were made on weekdays for the 12-hour period 7:00 a.m. to 7:00 p.m. The locations were placed into six groups according to how pedestrian volumes fluctuated from one 15-minute interval to the next throughout the course of the day.

Site 9, a midblock crossing located near the intersection of Connecticut Ave. and DeSalle St., NW, in an office/retail neighborhood, displayed a pronounced mid-day peak and smaller morning and late afternoon peaks (Figure 5-2). Pedestrian volumes were 600 or higher during each 15-minute interval between 12:00 noon and 1:30 p.m. Pedestrian volumes reached 400 during both the peak morning and late afternoon intervals. It is likely that the peaks correspond to when employees arrive at and depart from their offices and to mid-day lunch and shopping trips.

A bimodal distribution is depicted in Figure 5-3. Site 4, an intersection crossing at 23rd and H Streets, NW, was in a school and institutional setting. Pedestrian volumes exceeded 300 during several peak 15-minute intervals in the morning and late afternoon, but remained around 100 for each interval between the peaks. The peaks may reflect the influx of students and teachers, or perhaps hospital employees, depending on the exact land uses.

Some sites showed a series of peaks and valleys, i.e., considerable fluctuation throughout the day. Figure 5-4 depicts site 11, located at Connecticut Avenue and Woodley, NW, in a residential neighborhood. Fifteen-minute pedestrian counts were 150 or higher between 8:00 a.m. and 9:15 a.m., during several discontinuous intervals between 11:15 a.m. and 3:45 p.m., and during all but one interval between 5:00 p.m. and 7:00 p.m. These patterns might represent people walking to and from work, shopping, and social visits.

Table 5-1. Observed pedestrian flow rates in urban areas.

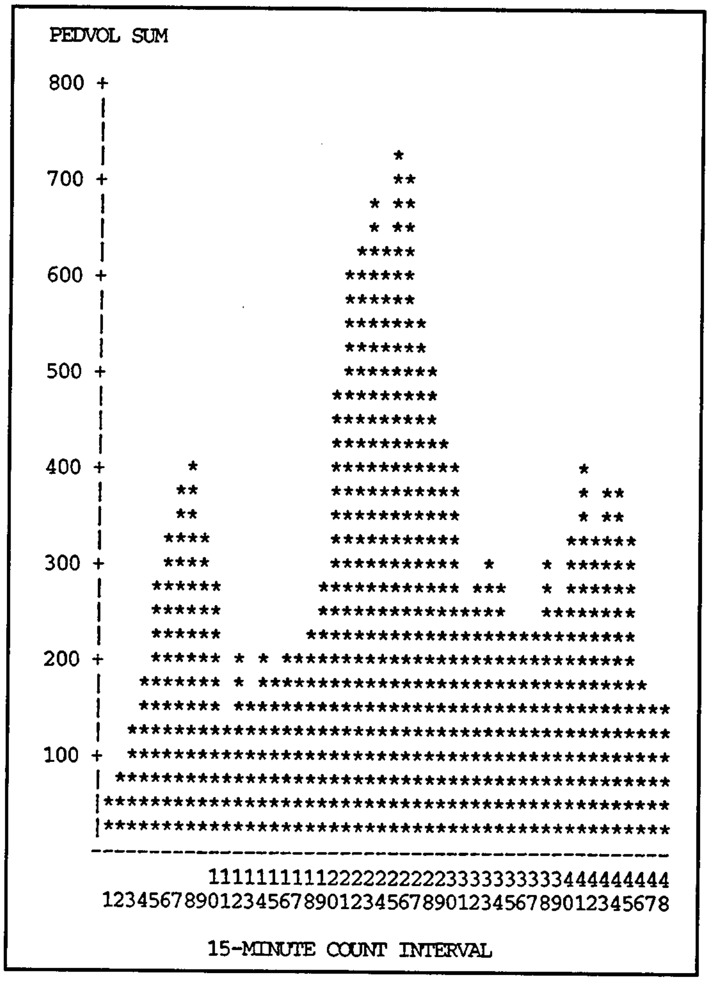
LOCATION	TIME	WALKWAY WIDTH (FT)	AVG. FLOW RATES FOR FULL HOUR PED/MIN	AVG. FLOW RATES FOR FULL HOUR PED/MIN/FT	PEAK FLOW RATES FOR PERIODS LESS THAN 1 HOUR PED/MIN	PEAK FLOW RATES FOR PERIODS LESS THAN 1 HOUR PED/MIN/FT
BOSTON						
Washington St (1960)	12-1 PM	7.0	53	7.6	—	—
CHICAGO						
CTA (1976)	PM	—	—	5.2	—	—
State St/Wash (1960)	12-1 PM	25.0	112	4.5	—	—
State St/Wash (1972)	4-5 PM	25.0	93	3.7	—	—
State St/Wash (1939)	12-1 PM	25.0	206	8.2	—	—
State St/Mad (1929)	—	25.0	342	13.7	471 (15 min)	18.8
State St/Mad (1929)	—	20.0	287	14.4	368 (15 min)	18.4
Soldiers Fld (1940)	—	21.5	202	9.4	298 (1 min)	13.9
Dyche Stadium (1940)	—	10.0	114	11.4	167 (5 min)	16.7
LOS ANGELES						
Broadway (1940)	—	18.0	—	—	125 (12 min)	6.9
DES MOINES AND AMES, IOWA						
Veteran's Aud. (1975)	10 PM	8.2	—	—	—	20.0 (5 min) 22.2 (1 min)
College Creek Footbridge (1975)	12 Nn	6.0	—	—	—	22.3 (5 min) 31.8 (1 min)
CY Stephens Auditorium (1975)	4:40 PM	7.5	—	—	—	31.9 (5 min) 39.2 (1 min)
Iowa State Univ. Armory	1 PM	2.8	—	—	—	28.7 (1 min)
NEW YORK CITY						
Madison Av (1969)	12-1 PM	13.0	167	12.8	—	—
Fifth Av (1969)	12-1 PM	22.5	250	11.1	—	—
Lexington Av (1969)	12-1 PM	12.0	100	8.3	—	—
Eighth Av (1969)	PM	15.0	167	11.1	—	—
42nd Street (1969)	PM	20.0	105	5.3	—	—
Port Authority Bus Terminal (1965)	PM	—	—	25.0	—	—
WASHINGTON D.C.						
7th St SW (1968)	PM	10.0	42	4.2	—	—
F Street NW (1981)	PM	15.0	19	1.3	—	—
SEATTLE						
CBD (1976)	PM	—	—	—	—	9.6
SAN FRANCISCO						
CBD (1976)	PM	—	—	—	—	10.8
WINNEPEG						
CBD Street (1980)	3-4 PM	17.0	74	4.4	—	—

Source: Transportation Research Board (1985).

New York, New York

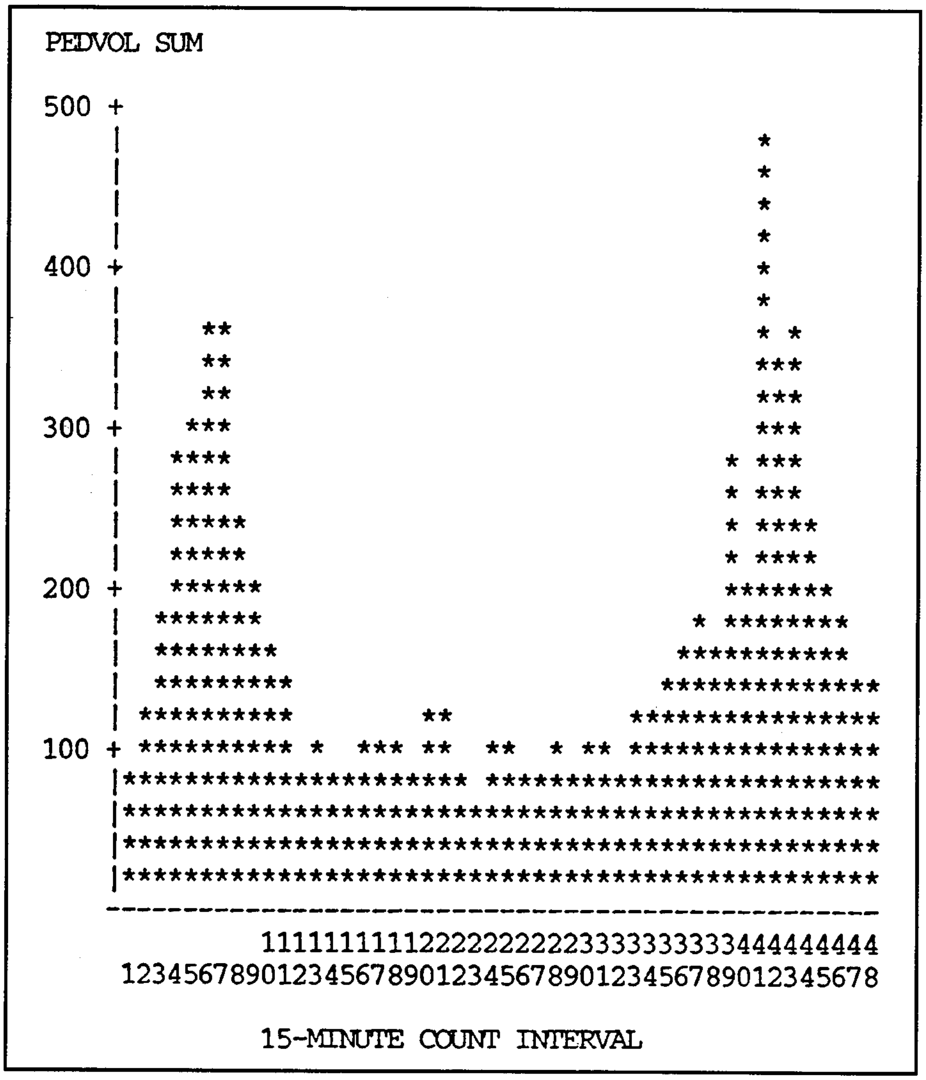
Pushkarev and Zupan's Urban Space for Pedestrians (1975) discusses how and why pedestrian space should be taken into consideration in urban design. Chapter 2 addresses pedestrian travel demand. The authors present the results of several facility-cordon studies, which counted pedestrians and motor vehicles that entered and left various facilities. The trip measurements were taken only for specific establishments, which were not selected according to any sampling methodology. Tables 5-2 through 5-5 illustrate the extent of tripmaking and allow comparisons by mode, location, and type of facility. Not surprisingly, the total number of trips and the number of walk only trips per resident or per 1,000 sq. ft. of floor space varies by location and establishment. For example, suburban residences and offices generate as many auto trips as urban residences and offices do for all modes, including walking. Two apartments in Manhattan, New York City, had 8.3 and 9.1 in and out trips on foot per 1,000 sq. ft. (Table 5-2) Offices produce about twice as many trips per sq. ft. as do residences. Except for a local use office, the office buildings listed in Table 5-3 had roughly 15 observed trips (in and out) on foot per 1,000 sq. ft. As shown in Table 5-4, the restaurant located in Times Square had 173 trips (in and out), and the other two restaurants had over 400 trips per 1,000 sq. ft. Most of the urban retail establishments listed in Table 5-5 had 200–500 total observed trips (in and out) on foot per 1,000 sq. ft. of floor space.

Figure 5-2 Fifteen-minute count histogram for site 9 (Connecticut Avenure and SeSalle Street, NW).



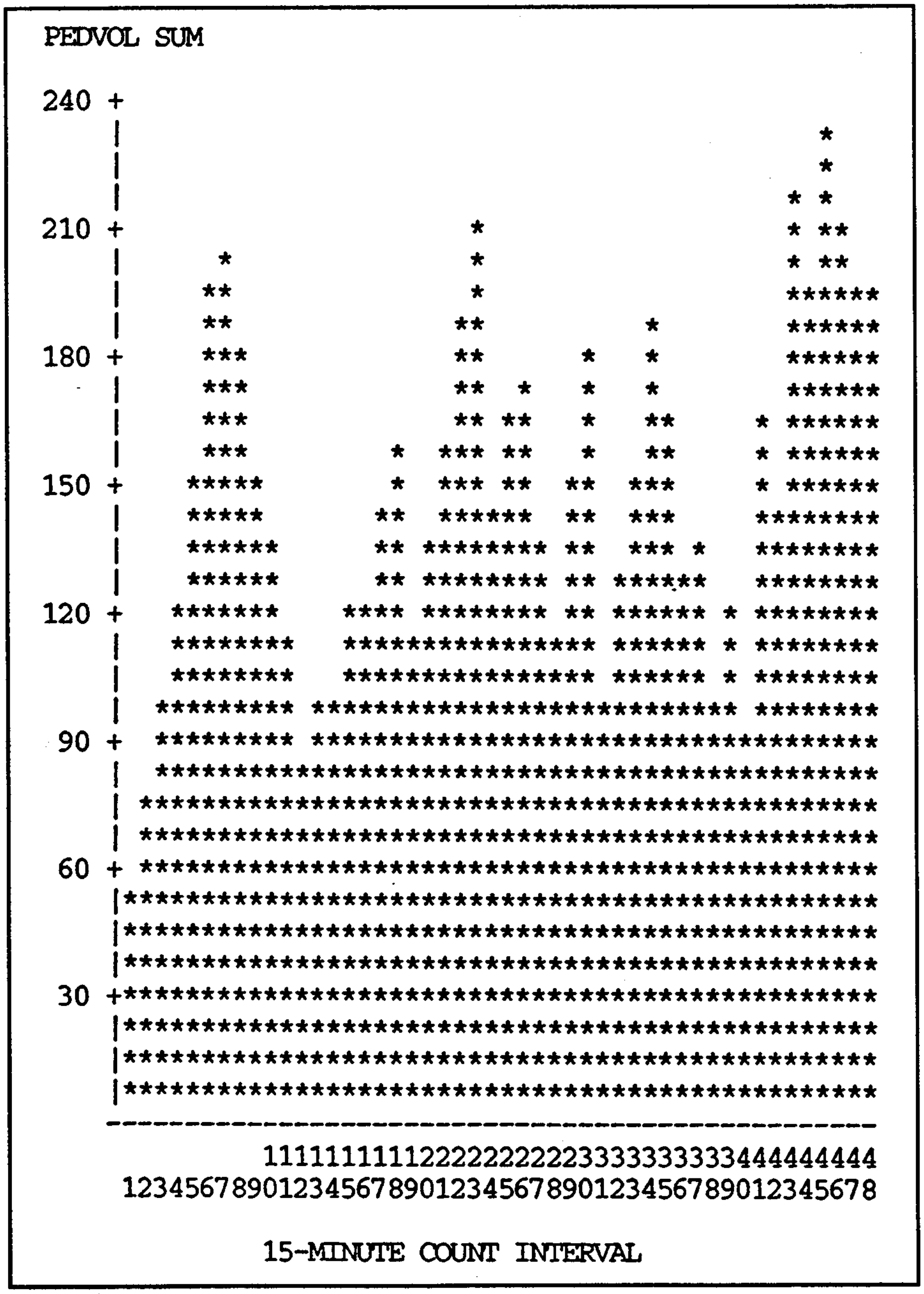
Source: Davis, et al. (1987).

Figure 5-3. Fifteen-minute count histogram for site 4 (23rd Street and H Street, NW).



Source: Davis, et al. (1987).

Figure 5-4. Fifteen-minute count histogram for site 11 (Connecticut Avenue and Woodley Road, NW).



Source: Davis, et al. (1987).

The peaking pattern, or daily cyclical variation, refers to how trips are distributed throughout the day and, thus, when demand on travel facilities is strongest. Figure 5-5 shows in/out pedestrian volumes for 15-minute intervals at five buildings in Manhattan. The two office buildings have peaks corresponding to when employees arrive in the morning, leave for and return from lunch, and leave in the afternoon. The department store and the restaurant experience peak pedestrian flows during mid-day hours. Trips in and out of the residential building show a trough between 10 a.m and 4 p.m., but the peaks are less distinct than for the other four buildings. One-way peaks at the two offices are even sharper, with four to seven times the average 15-minute pedestrian count occurring during the 15-minute period (Figure 5-6).

Pedestrian travel demand peaks on outdoor walkways are less pronounced than at building entrances, because of varying trip lengths, destinations, and peak times for each building. For five outdoor walkways, the peak 15-minute flow rate was roughly twice the average 15-minute flow (Figure 5-7). The heaviest 12-hour pedestrian count along these five walkways was 89,700, on the Grand Central train station escalators. Two 15-minute periods during the morning and two in the afternoon accounted for 17.2 percent of the pedestrian flow. At the opposite extreme, the average per sidewalk location along 48th Street was 5,650. The diurnal pattern varied with whether the pedestrians using the walkways were commuters, shoppers, or casual walkers.

Table 5-2. Comparison of vehicular and pedestrian trip generation by residences.

Location	No. of dwellings observed	Trips entering and leaving during 24 hrs. — Vehicles, observed — per dwelling	Vehicles, observed — per resident	Persons in vehicles, assumed — per resident	
Single family dwellings					
				(assume 1.6 persons per auto trip)	
1. Maryland	8,778	8.64	2.34	3.7	
2. California	5,719	9.49	2.56	4.1	
3. Long Island	208	11.40	2.41	3.9	
Suburban apartments					
				(assume 1.4 persons per auto trip)	
4. Virginia	2,508	7.58	3.45	4.8	
5. Maryland	3,029	7.30	3.17	4.4	
6. California	2,821	5.90	3.28	4.6	
Urban apartments					
		Trips entering and leaving during 24 hrs on foot, observed — per dwelling		per resident	per 1,000 gross sq ft (93 m²)
7. Manhattan, 30th St.	288*	7.6		4.5	8.3
8. Manhattan, 12th St.	136†	8.0		5.0	9.1

Source: Pushkarev and Jupan (1975).

Table 5-3. Comparison of vehicular and pedestrian trip generation by offices and a museum.

	Location	Gross fl. space, sq ft	Trips entering and leaving during 24 Hrs per 1,000 sq ft (93 m^2) of fl. space	
Suburban office buildings				
			Observed vehicle trips	Assumed person trips at 1.2 persons per auto
1.	New Jersey	186,000	17.9	21.5
2.	Maryland	170,000	17.5	21.0
3.	Long Island	1,180,000	15.0	18.0
4.	Virginia	836,000	8.9	10.7
Urban office buildings				
Type			% Walk-only trips	Observed person trips in and out on foot
5. Local use	Bronx	59,000	n.a.	58.0
6. Mixed use	Manhattan	314,000	n.a.	17.3
7. Headquarters	Manhattan	1,634,000	26	14.2
8. Headquarters	Manhattan	1,048,000	26	13.2
9. 24 bldgs.	Seattle	5,241,000	n.a.	15.4
10. Museum of Modern Art	Manhattan	227,000	26.8	21.0

Source: Pushkarev and Zupan (1975).

Table 5-4. Comparison of vehicular and pedestrian trip generation by restaurants.

Type	Location		Trips entering and leaving during 24 Hrs per 1,000 sq ft (93 m^2) of fl. space	
Suburban establishments			Observed vehicle trips	Assumed person trips at 2.5 persons per vehicle
1. 2 restaurants	New Jersey		72.2	180
Manhattan establishments				
		Gross fl. space sq ft	Period of count	Observed person trips in and out on foot
2. Cafeteria	57th St.	7,200	wk. day 10 A.M.- 8 P.M.*	492
3. Sandwich shop	Garment Dist.	1,000	wk. day 6 A.M.- 3 P.M.	430
4. Restaurant	Times Sq.	12,000	wk. day 9 A.M.- 9 P.M.*	173

Source: Pushkarev and Zupan (1975).

Table 5-5. Comparison of vehicular and pedestrian trip generation by retail stores.

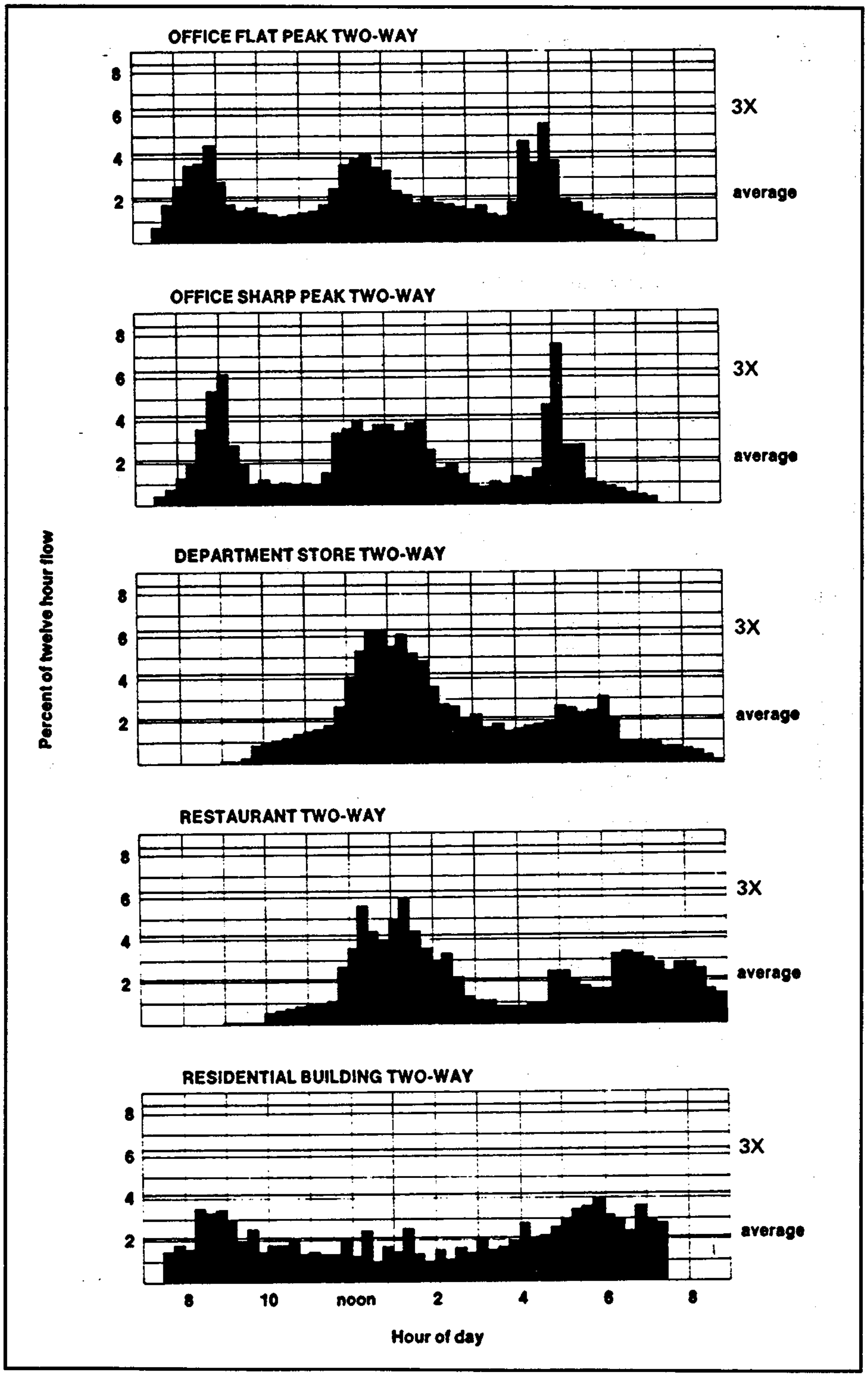
	Trips entering and leaving during 24 Hrs per 1,000 sq ft (93 m^2) of fl. space	
Suburban shopping centers	Observed vehicle trips	Assumed person trips at 2.0 persons per vehicle
1. Average of 21 neighborhood centers (under 100,000 gross sq ft)	79	158
2. Average of 44 Community centers (100,000 - 499,999 gross sq ft)	56	112
3. Average of 23 regional centers (over 500,000 gross sq ft)	30	60

Urban establishments

Type	Location	Gross fl. space sq ft	Period of count	Observed person trips in and out on foot	% walk-only trips
4. Delicatessen	Manhattan	2,500	Sa. 10 A.M.-10 P.M.*	2,460	70
5. Supermarket	Queens	7,500	wk. day 9 A.M.-9 P.M.	428	n.a.
			Sa. 9 A.M.-9 P.M.	536	n.a.
6. Supermarket	Manhattan	5,100	Sa. 9 A.M.-6 P.M.	509	n.a.
7. Jun. dept. store	Manhattan	69,600	wk. day 9 A.M.-9 P.M.	385	n.a.
8. Supermarket	Manhattan	14,500	wk. day 9 A.M.-9 P.M.	372	n.a.
9. Supermarket	Richmond	7,500	wk. day 9 A.M.-9 P.M.	285	n.a.
10. Dept. store	Manhattan	176,700	wk. day 9 A.M.-9 P.M.	252	n.a.
11. Boutique	Manhattan	3,400	wk. day 11 A.M.-7 P.M.*	205	61
			Sa. 10 A.M.-6 P.M.	488	81

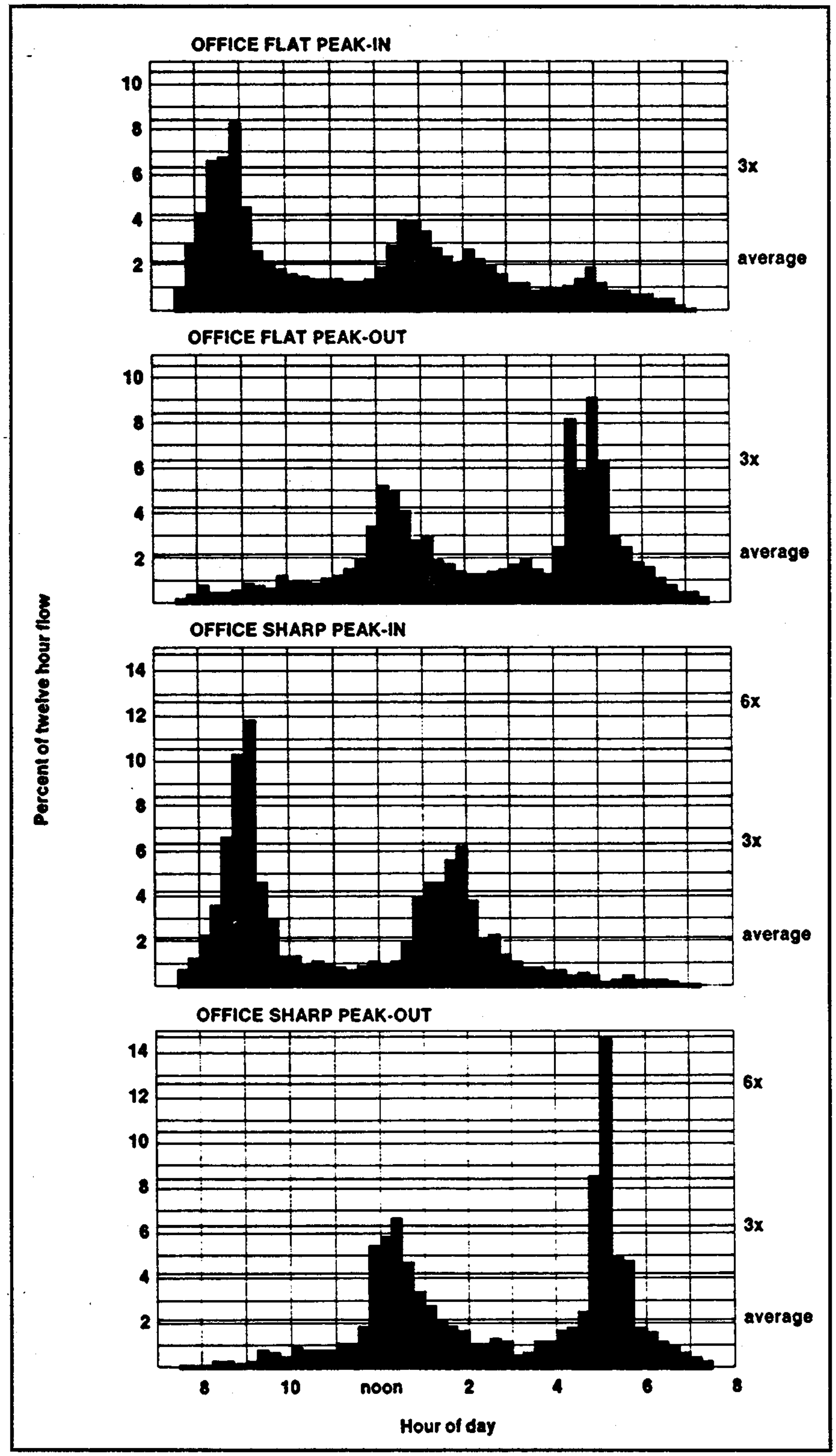
Source: Pushkarev and Zupan (1975).

Figure 5-5. Two-way daily peaking patterns at five building types.



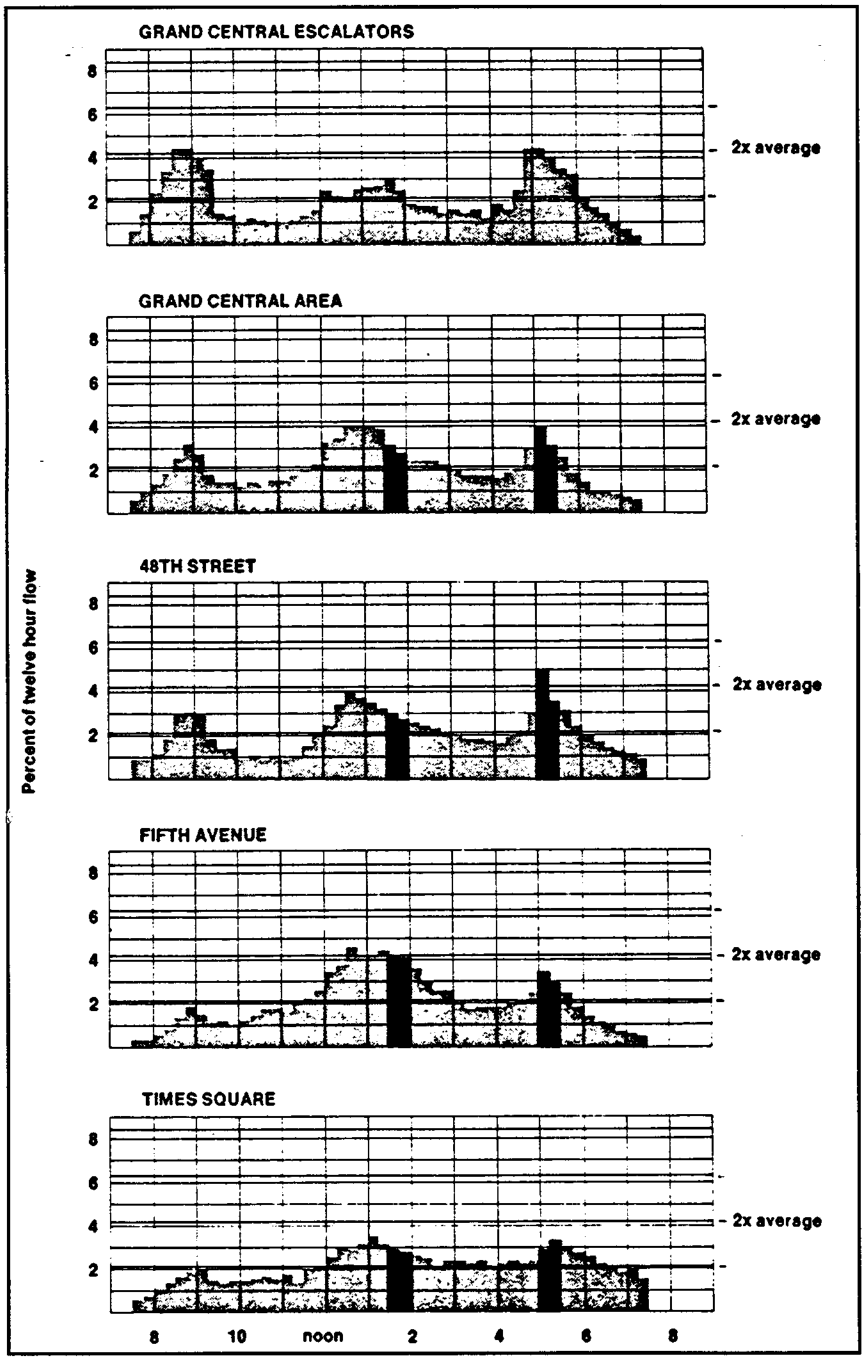
Source: Pushkarev and Zupan (1975).

Figure 5-6. One-way daily peaking patterns at two office buildings.



Source: Pushkarev and Zupan (1975).

Figure 5-7. Two-way daily peaking patterns on walkways.



Source: Pushkarev and Zupan (1975).

At one office building in midtown Manhattan, five 12-hour pedestrian counts were made in a week. The pedestrian volume was highest on Wednesday. Tuesday and Thursday were 2 percent lower, while Monday and Friday were 4 percent lower.

The seasonal variation in subway patronage was used to indirectly estimate seasonal variations in the number of pedestrians in Manhattan¿¿s Central Business District. Subway ridership was highest in May and June (103 percent of the average month) and lowest in July and August (95 percent of the average month).

To determine trip length and purpose, the researchers interviewed a sample of 4,055 pedestrians representing a population of 63,000 persons who were entering or leaving a building or transit station in midtown Manhattan. One thousand four hundred of these interviews represented about 17,000 pedestrians entering or leaving two large office buildings. The average walking trip was 1,720 feet at a speed of 285 feet/minute (Table 5–6). Males aged 25–50 walked the farthest, 2,044 feet, and females over 50 walked the shortest distance, 1,244 feet. On average, men walked 1,900 feet at 298 ft/min, whereas women walked 1,520 feet at 268 ft/min.

Pushkarev and Zupan estimated that between 50 and 60 percent of the trips in and out of the two office buildings were home based. Of the non-home based trips, eating trips were the most numerous, followed by business calls, shopping, pleasure, and deliveries.

About 26 percent of all trips to/from the offices were exclusively walking; for the other trips, walking was either the initial or final segment of a linked multimodal trip. Eating and shopping trips were overwhelmingly walk-only. The average distance walked varied according to purpose. Eating trips averaged 1,073 feet, while shopping trips were twice as long.

The last part of Chapter 2 covers the cost of walking. Because time spent walking is time not spent on other activities, people may be willing to pay to avoid walking. The value an individual places on not walking can be estimated by dividing the cost associated with another mode (such as parking fees, taxi fares, or bus fares) by the distance not walked or the time saved if the other mode were used. For example, the authors calculated that the higher cost of long-term parking close by translated into 65 cents for every 1,000 feet not walked, in

Table 5-6. Walking distance by age and sex at two office buildings.

Group	% of trips	Av. walking distance ft	(m)	Estimated av. net walking time min.
Males, under 25	10.2	1,502	(458)	4.70
Males, 25-50	35.1	2,044	(623)	6.83
Males, over 50	6.5	1,711	(522)	6.50
Females, under 25	28.8	1,608	(490)	5.80
Females, 25-50	14.6	1,443	(440)	5.47
Females, over 50	4.8	1,244	(379)	5.59
All males	51.8	1,900	(579)	6.37
All females	48.2	1,520	(463)	5.67
Total (16,740 trips)	100.0	1,720	(524)	6.03

Source: Pushkarev and Zupan (1975).

1969 prices. Taking the subway from the Grand Central area to the bus terminal cost 9 cents per 1,000 feet. Low-income workers outside Manhattan valued not walking to subway stations at 12 cents per 1,000 feet.

Figures 5-8 and 5-9 show the trade-off between walking and riding to the bus terminal and to subway stops. For the bus terminal, nearly everyone walked distances of less than 1,000 feet, and about 40 percent of those traveling 1 mile walked. For the subway stops, nearly everyone walked distances of less than 1,000 feet, but less than 10 percent walked when the distance was 1 mile.

Temperature and rain are also factors in the cost of walking. A series of counts made over a 2-year period at a park in midtown Manhattan suggested that a significant amount of pleasure walking occurs at temperatures above 55 degrees Fahrenheit. Heavy rain reduced the number of pedestrians on the 42nd Street sidewalk by 24 to 55 percent, depending on the intensity of the rain. Most of the pedestrians opted for the subway in rainy weather; others shortened or canceled their trips.

In another part of their research, the authors delineated a 1.2 square-mile study area in midtown Manhattan. From aerial photographs taken between 1:28 and 1:59 p.m. on several weekdays, over 37,000 pedestrians were counted in the study area. The total was somewhat lower during evening rush hour. The counts were tabulated by blocks and sections of blocks. The highest flow rate, 12,000 pedestrians per hour, was on the west side of Fifth Avenue at 47th Street. Some sections of sidewalk along Madison, Lexington, and Third Avenues had about 6,000 pedestrians per hour.

Pushkarev and Zupan then derived equations to statistically relate the number of pedestrians counted (from the aerial photographs) in each block section to building floor space and walkway space. Separate equations pertain to streets (which run east to west) and avenues (which run north to south, are generally perpendicular to streets, and have about half the sidewalk width), and midday and evening.

(1) Avenues, midday

$$P = 2.97 \text{ walkways} + 0.05 \text{ office} + 0.35 \text{ retail} + 1.22 \text{ restaurant} + 2.66$$

(2) Streets, midday

$$P = 3.12 \text{ walkway} + 0.06 \text{ office} + 0.12 \text{ retail} + 0.74 \text{ restaurant} - 4.01$$

(3) Avenues, evening

$$P = 0.06 \text{ office} + 0.20 \text{ retail} - 1.98\, D + 56.70$$

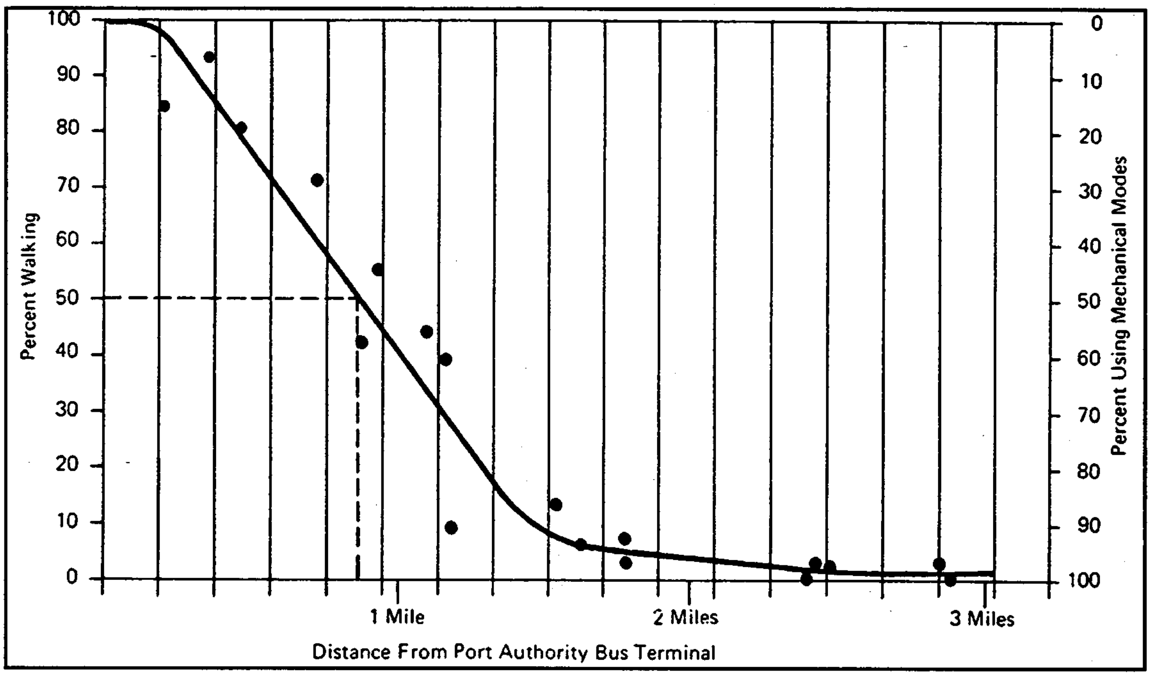
(4) Streets, evening

$$P = 3.17 \text{ walkway} + 0.04 \text{ office} + \frac{46.12}{D^3} + 2.17$$

where

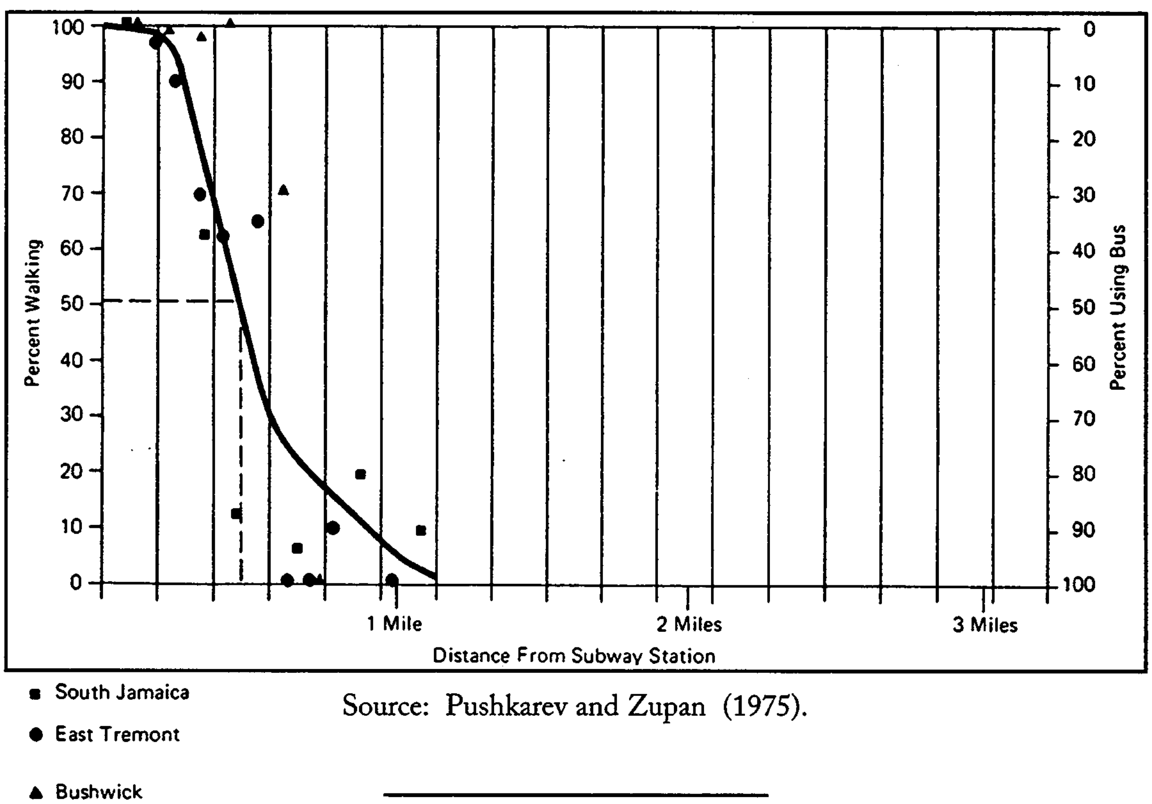
P	=	number of pedestrians at an instant in time on the sidewalks, plazas, and in the vehicular roadway of a block sector.
Walkway	=	sidewalk and plaza space on the block sector, in thousands of square feet (92.9 m^2).
Offic, retail, restaurant	=	gross office, retail, and restaurant floor space, respectively, in the block sector, in thousands of square feet (92.9 m^2).
D	=	distance from the centroid of the sidewalk and plaza space to the nearest entrance, in hundreds of feet (30.5).

Figure 5-8. The trade-off between walking and riding to the Port Authority Bus Terminal.



Source: Pushkarev and Zupan (1975).

Figure 5-9. The trade-off between walking and riding to subway stops in low-income areas.



Source: Pushkarev and Zupan (1975).

Although Pushkarev and Zupan covered pedestrian volumes and facility design quite thoroughly, the New York City pedestrian counts date back 20 years or more. One of the few available recent counts for that city was done during the summer of 1993, when the New York City Department of Transportation counted pedestrian volumes for 15-minute intervals between 11:00 a.m. and 2:00 p.m. on weekdays before and after Fulton Street was closed to vehicular traffic.[11] The average pedestrian volume before closure was 4,132 per hour, while the average volume after closure was 4,594, an increase of 11.3 percent. Pedestrians often move in platoons because of random, short-term fluctuations in pedestrian flow. For example, traffic signals interrupt flow, and transit vehicles can deliver many pedestrians within a few minutes. Platoon flow level of service prior to closure was C or worse 80.0 percent of the time, but only 12.5 percent of the time following closure, as the entire width of the street became available to pedestrians.

Chicago, Illinois

In 1981 and again in 1989, more than 3 million pedestrians were counted and roughly 1,500 pedestrians were interviewed in Chicago's central business district (Soot, 1991). Both studies included 10-hour midblock counts; about 300 sites were common to both studies. Pedestrian interviews were conducted by land use zone and time of day (peak, lunch, and off-peak).

In 1989, 10-hour pedestrian volumes ranged from less than 1,000 to more than 30,000. In both years, the sites with volumes exceeding 30,000 were major retailing sites. Two of the bridges crossing the Chicago River about 1,000 feet (300 m) from two commuter rail stations had over 2,000 pedestrians on one side of the bridge during peak 15-minute periods in 1989. Pedestrians came in waves, with little activity between waves. The data did not show unusually high numbers of pedestrians near the two largest office buildings — the Sears Tower and the Merchandise Mart. The Sears Tower occupies an entire block; the highest pedestrian counts along the four block faces in 1989 were 17,900 and 15,700, where the main entrances are located. Neither side of the two bridges connecting the Merchandise Mart with the central business district had over 5,000 pedestrians.

In 1981, 25 sites had over 20,000 pedestrians, and 86 sites had 5,000 or fewer. By 1989, only 13 sites had over 20,000, and 70 sites had 5,000 or fewer. State Street (the traditional shopping district) had seven sites with over 25,000 pedestrians in 1981 with none in 1989, a reflection of the shift in retailing away from State Street. In general, pedestrian volumes declined in the eastern part of the central business district and increased in the western part. The eastern part had not seen much new office construction, whereas the western part had significant office growth.

The interviews showed that in 1981 and 1989 about two-thirds of all pedestrians came downtown to work. Shopping was the primary trip purpose for 8.0 percent in 1981 but only 4.5 percent in 1989. The median distance walked remained about two blocks, and about two-thirds of weekday pedestrians were men.

To adequately estimate pedestrian traffic at a specified site, a model must incorporate the land use in its immediate vicinity and its location relative to major central business district entry points. The author suggests that a 1-hour sample be obtained and compared with the appropriate signature, which is the daily pattern of pedestrian traffic as shown by prior observations. The Chicago counts showed that a site's signature changed very little between 1981 and 1989. Thus, the percent of the 1989 daily total reflected in a 1-hour sample can be estimated by comparing the sample with the 1981 total in the signature. Then, the current daily total can be estimated.

[11] Personal correspondence from Glynis Berry, Director, New York City Department of Transportation, Pedestrian Projects Group, March 22, 1994.

Heemstede, Netherlands

In the Netherlands, new pedestrian crossing facilities use relocated displays and mat detectors instead of push buttons (Levelt, 1992). At an intersection near the rail station in Heemstede, pedestrian crossings were videotaped on three days in August 1991, less than two months after the new facilities came on line. Table 5-7 shows that an average of 72 pedestrians per hour used a specific crossing at an intersection near the railway station.

During evening rush on Wednesday (4:30 p.m. to 5:30 p.m.), the pedestrian count was 106. Only 40 pedestrians were counted between 11:00 a.m. and 12:00 noon on Thursday. Slightly over one-half of the observed pedestrians were men, and two-thirds were ages 21–60.

Table 5-7. Characteristics of pedestrian traffic flow and number of green phases.

		Pedestrians							
day/hour	N gr	ped	men	wom	-20	-60	>60	fr.st	to st
Thur. Aug. 29									
07.23-08.00	13	60	48	12	5	55	0	5	55
08.00-09.00	26	98	65	33	21	71	6	21	77
09.00-10.00	17	63	36	27	14	30	19	23	40
10.00-11.00	20	67	27	40	7	33	27	34	33
11.00-12.00	11	40	11	29	8	25	7	15	25
12.00-13.00	15	65	28	37	20	39	6	23	42
13.00-14.00	19	76	32	44	10	58	8	46	30
14.00-15.00	17	60	32	28	8	31	21	37	23
15.00-16.00	15	50	28	22	10	32	8	28	22
Wedn. Aug. 28									
16.30-17.30	17	84	49	35	11	59	14	45	39
17.30-18.30	18	106	62	44	21	80	5	73	33
Satu. Aug. 28									
12.00-13.00	24	89	39	50	17	58	14	52	37
13.00-14.00	14	70	37	33	13	47	10	32	38
14.00-15.00	18	73	30	43	12	48	13	32	41
Total	244	1001	524	477	177	666	158	466	535
Av.hour	17	72	37	34	13	48	11	33	38
av.cycle		4,1	2,1	2,0	0,7	2,7	0,6	1,9	2,2

N gr number of green phases
ped number of pedestrians
men number of men
wom number of women
-20 age: 0-20
-60 age: 21-60
>60 age: >60
fr.st coming from station
to st going to station

vehic number of vehicles
motv number of motorvehicles
bicy number of bicyclists

Source: Levelt (1992).

CHAPTER 6.
MULTI-USE TRAILS AND PATHS

Introduction

Many facilities are built to serve multiple users, such as bicyclists, walkers, and joggers. These multi-use trails and paths are usually completely segregated from motor vehicle traffic. They are sometimes created along abandoned railroad corridors. As these trails often traverse parks, greenways, or other wooded settings, many cyclists and pedestrians use the trails for recreational purposes. Other trails are used by individuals commuting to and from work or school.

This chapter presents trip counts for multi-use trails and paths. When available, breakdowns of bicycle and pedestrian travel are given. As with the preceding chapters, the information is arranged geographically.

Site Descriptions

Clearwater—Largo—St. Petersburg, Florida

The Pinellas trail is a popular facility on the west coast of Florida. At present about 33 miles of trail are open with 14 additional miles planned to be built in the next few years. The trail is nominally 15 feet wide (10 feet for bicycles and in-line skaters and 5 feet for pedestrians) and paved with asphalt. A 12-hour (6:30 a.m. to 6:00 p.m.) survey of users was conducted on Tuesday, November 9, 1993, by the Pinellas County Department of Planning.[12] Eight locations near traffic generators such as schools, shopping centers, recreation areas, and medical centers were used as survey sites along the 23 miles of trail in use at the time of the survey. Volunteers handed out a brief, self-administered questionnaire to trail users. To protect against double counting, users were asked if they had already filled out a survey. The survey produced 967 responses. Participation was felt to be good, and some who did not participate in the survey were serious runners and cyclists using the trail for training, along with others who were on their way to work or school. The weather on the survey day was good, although a predicted 60 percent chance of showers may have lowered actual trail use.

By comparison, the Pinellas County Parks Department estimates 2,000 – 3,000 users on weekdays, but their counting method is different. Their total derives from an actual count of users made by a park ranger during a 1-hour bike ride along the trail, multiplied by the number of daylight hours.

Some of the general survey results can be stated as follows:

- Use varied little by time of day.
- 63% of the users were male.
- 64% were adults aged 25-65.
- 40% live less than 1/4 mile, and 35% live more than 1 mile from the trail.
- 55% usually travel less than 5 miles each way on the trail, and 45% more than 5 miles.
- 88% used the trail at least twice a week, and 45% at least 5 days per week.
- 67% use the trail for recreation, exercise, etc., and 33% for transportation to work, school, stores, etc.

[12] Preliminary results provided by Kay Medwick, Pinellas County Department of Planning.

- 60% of commuters use the trail 5 days per week, and 87% at least 2 days per week.
- 51% used a bike to get to the trail, while 27% walked, 20% used a car, and 2% some other means.
- The distance from trail to destination was less than 1/4 mile for 29% of users, and more than 1 mile for 41% of users.

Seattle, Washington

A May 1990 survey of users of the Burke-Gilman/Sammamish River Trail in Seattle provides interesting data[13]. Six count stations were used along the 25 miles of trail from Seattle to Redmond. At the time of the survey all but 1.5 miles was a Class I facility. Volunteers worked at stations from 7 a.m. – 7 p.m. on a Saturday and a Tuesday, counting total trail users in each direction by mode of travel and distributing survey cards to willing recipients. About 3,200 cards were returned and analyzed. The weather was moderate and without rain on both survey days. Total number of users by day are shown in Table 6-1 below:

Table 6-1. Trail users by mode of travel.

	Bicyclists	Joggers	Walkers	Others	Total
Saturday, May 19, 1990	13,204	1,153	1,367	148	15,872
Tuesday, May 22, 1990	4,225	931	992	61	6,209

Source: Personal correspondence from Bill Moritz.

It is acknowledged that double counting is present in these totals, but the extent is unknown. A bicyclist traveling from one end to the other and back would have been counted 12 times.

Figure 6-1 plots the number of bicyclists by time of day at the station near the University of Washington, with westbound being toward the university. Westbound flow peaked at about 190 bicyclists per hour from 2–3 p.m. on Saturday. The Tuesday plot shows a peak of about 180 bicyclists per hour westbound from 5–6 p.m.

Additional results from the user survey cards include the following:

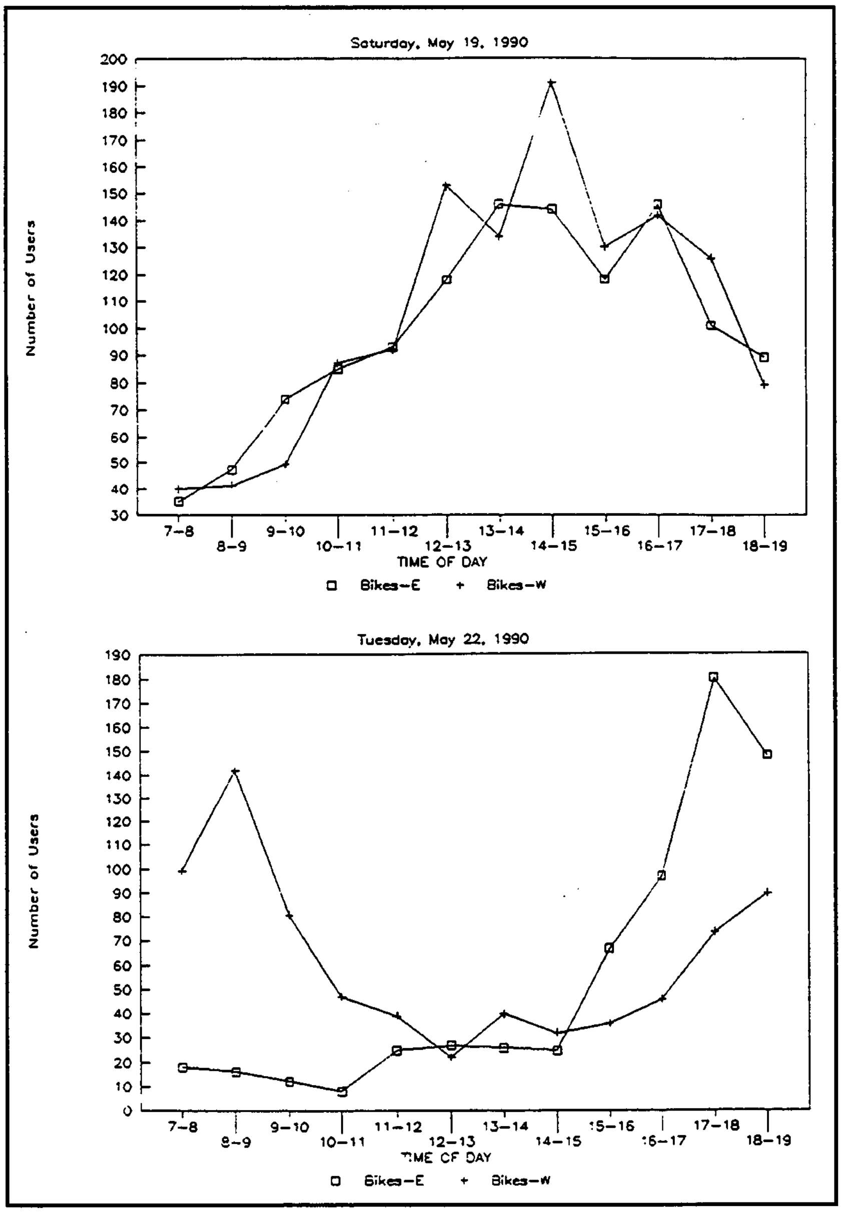
	Saturday	Tuesday
- Average distance on the trail	13.9 miles	7.4 miles
- Average number of trail uses per year	79.9	149.3
- Average number of trail uses per month	9.8	14.4
- Percent users male	61%	64%
- Average income	$32,000	$27,000

[13] Personal correspondence from Bill Moritz, University of Washington.

Iowa—Florida—California

A sample of three diverse rail-trails from across the United States was studied during 1990 and 1991 (Moore et al., 1992). Eight years old at that time, the 26-mile, crushed limestone surfaced Heritage Trail traverses rural farmland in eastern Iowa. This trail was estimated to have 135,000 visits annually—65 percent bicycling, 29 percent walking, and 6 percent other. The 16-mile paved St. Marks Trail, dedicated in 1988, parallels State Road 363 and begins on the outskirts of Tallahassee, Florida, and passes through small communities and forests toward the Gulf of Mexico. This trail was estimated to have 170,000 visits annually—81 percent bicycling, 9 percent walking, and 10 percent other. The Lafayette/Moraga Trail, which opened

Figure 6-1. Number of bicyclists by time of day at count station near the University of Washington.



Source: Personal correspondence from Bill Moritz, University of Washington.

in 1976, is a 7.6-mile paved trail 25 miles east of San Francisco, California, and travels almost exclusively through developed suburban areas. This trail was estimated to have 400,000 visits annually—20 percent bicycling, 63 percent walking, and 17 percent other.

Washington, D.C.

Several sources of counts on trails in and near Washington, D.C., are quoted in a report compiled by the Denver Service Center (1990). In August 1983, an 11-hour Sunday count found 1,048 users along a section of the Mount Vernon Trail south of Alexandria. Fifty-five percent of the total were cyclists, with runners/joggers and walkers accounting for the remainder. An 11-hour Monday count found 788 users and nearly the same distribution of cyclists, runners, and walkers.

A 1985 study counted 820 users per day on the Mount Vernon Trail at the Memorial Bridge and only 400 users per day at the 14th Street Bridge (Table 6-2). The mix of users varies by location along the trail. At the Memorial Bridge, 50 percent of the users were cyclists and 60–65 percent were commuters. Nearly four-fifths of the users at the 14th Street Bridge were cyclists; 75–80 percent were commuters.

In the summer of 1986, 120 to 320 cyclists per hour used the entire Mount Vernon Trail. The busiest times were 8 to 11 a.m and 2 to 5 p.m.

At two other locations along the Mount Vernon Trail, Belle Haven and Daingerfield Island, automatic counters found that user volumes vary seasonally (Table 6-3). The authors do not offer explanations for the unusually high counts at Belle Haven in May 1988 or July 1989, nor for the low count at Daingerfield in July 1988.

According to a 1987 survey, 70 percent of the trail users on weekends in Rock Creek Park are cyclists. Near the Kennedy Center, 1,700 people per day use the trail on weekends, compared with 860 per weekday. About one-fourth of the cyclists wore helmets.

Other United States Cities

A case study done for the National Bicycling and Walking Study by Greenways Incorporated (1992)

Table 6-2. Usage of the Mount Vernon Trail in 1985.

	Mount Vernon Trail at	
	Memorial Bridge	14th St. Bridge
Users per day	820	400
Percentage cyclists	50%	78%
Percentage runner and joggers	45%	20%
Percentage commuters	60-65%	75-80%
Percentage adult males	80%	80%
Percentage wore helmets	50%	50%
Those coming from Arl. Cemetery	63%	n/a
Those crossing Memorial Bridge	85%	n/a
Those heading north	n/a	75%
Those crossing the 14th St. Bridge	n/a	50%

Source: Denver Service Center (1990).

Table 6-3. Monthly user volumes at two locations along the Mount Vernon Trail.

	Belle Haven		Daingerfield	
Month	1988	1989	1988	1989
January	779	2,526	927	3,344
February	2,347	4,159	2,791	5,541
March	6,327	10,128	7,703	12,905
April	9,718	6,624	13,435	11,095
May	26,613	13,074	16,386	16,434
June	15,491	14,929	17,723	16,180
July	15,383	43,674	7,262	18,941
August	13,652	13,652	14,859	15,355
September	2,156	10,501	14,043	14,428
October	n/a	9,904	n/a	19,129
November	n/a	n/a	n/a	n/a
December	n/a	n/a	n/a	n/a

Source: Denver Service Center (1990).

cites 60 examples of bicycle and pedestrian trails throughout the United States. One section discusses the various benefits of trails—transportation, recreation, economic, education, environmental, etc. The report compares and contrasts representative trails, noting similar characteristics among trails that have provided similar benefits. Design and maintenance of successful trails are also examined.

Finally, trail usage counts are reported (pp. 57-58), which are reproduced below. The case study notes that this type of data was not easily compiled. (In fact, Greenways, Inc., found few usage counts after reviewing materials within their own libraries and the libraries of the North Carolina Department of Transportation Bicycle Program and the National Greenway Archive). An asterisk (*) denotes a project that has detailed trip generation rates and usage data studies available.

- AVENT FERRY ROAD BICYCLE PATH (Raleigh, NC)
  1,331 people traveled along the corridor in a 12-hour period on September 14, 1988. Of these, 861 were observed using the bike path, others used the opposite sidewalk and road right-of-way.
  More bikers used the path rather than street or sidewalk. Nearly 3 out of every 4 of the pedestrians and 5 out of 6 joggers used the path.

- BURKE-GILMAN TRAIL (Seattle, WA)
  In 1987, the trail had an estimated 3/4 million users per year. As many as 4,000 to 5,000 users enjoy the trail on a busy day. Eighty percent of these are bicyclists.

- CARRBORO RAILROAD BIKE/PED TRAIL (Carrboro, NC)
  A 1983 count found 1,100 bikers per day.

- CHERRY CREEK TRAIL (Denver, CO)
  Use can reach 100–200 cyclists per hour during peak times and locations.

- EAST BAY BICYCLE FACILITY* (along Narragansett Bay, RI)
  Attracts more than 8,000 people per weekend day -- quadruple the predicted use level—and the trail is not yet open in Providence.
  Data collected in 1990 show an average modal split of approximately 80 percent bicycles and 20 percent pedestrians. Estimated average daily bicycle traffic varies from 200 to 475 at different locations along the trail.

- ELROY-SPARTA STATE TRAIL (Monroe and Juneau Counties, WI)
  Annual visitor use is approximately 60,000.

- HEARTLAND STATE TRAIL (Park Rapids to Walker to Cass Lake, MN)
  An estimated 47,330 people used the trail between May 21 and September 9, 1989, an increase in use of 16% from the summer of 1987. Seventy-six percent of these trail users were adults. Fifty-four percent were riding bicycles. Twenty-one percent of all use took place on weekends.

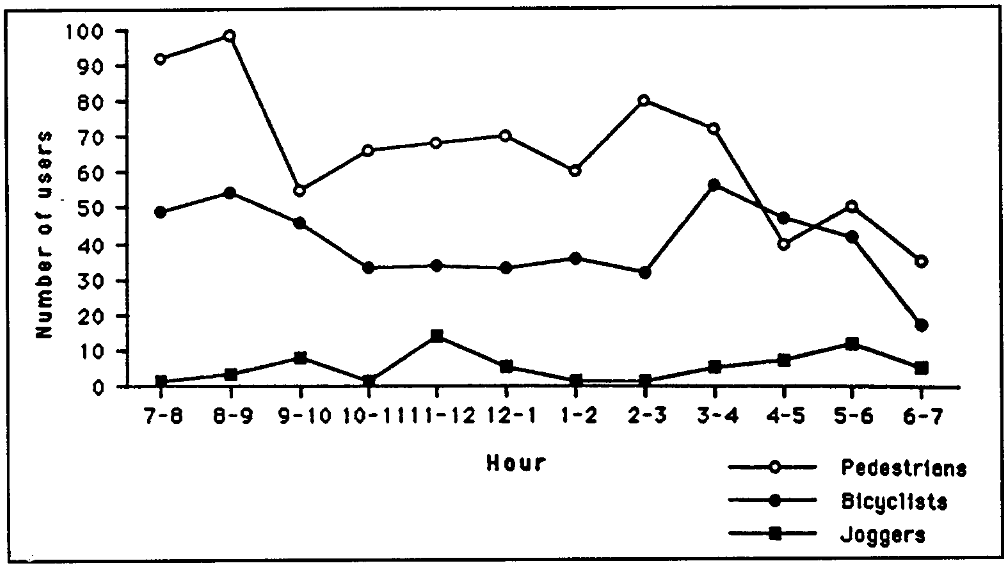
- ILLINOIS PRAIRIE PATH (Cook, DuPage, and Kane Counties, IL)
  The trail generates at least 300,000 user trips annually.

- NATIONAL CAPITAL REGION TRAILS* (MD, VA, and Washington, DC)
  A total of 369 users were reported in a 4-hour period on Sunday, July 22, 1990, on the I-66/ CUSTIS TRAIL. Ninety percent of these were bicyclists, of which 53 percent wore helmets. Ten percent were pedestrians.
  On July 26, 1990, 331 bicyclists, 61 percent of which were wearing helmets, rode on MEMORIAL CIRCLE in a 2.5-hour period.
  The MT. VERNON TRAIL reported 78 percent bicycle use and 22 percent pedestrian use during a four-hour period on Saturday, July 21, 1990.
  During a 2-hour period on the morning of June 19, 1990, 228 bicycles used ROSSLYN CIRCLE.
  On Sunday, July 8, 1990, 652 users were reported in a 3-hour period on the WASHINGTON and OLD DOMINION TRAIL. Seventy-one percent were bicyclists, 17 percent joggers, and 12 percent walkers.

In Raleigh, North Carolina, the Avent Ferry Road Bicycle Path intersects both Western Boulevard (near the campus of North Carolina State University) and Gorman Street (a little over one mile south of the campus). Hourly pedestrian usage at Western Boulevard was highest (90-100) between 7–9 a.m., decreased to around 60–70 during the mid-day hours, increased slightly between 2 and 4 p.m., then decreased to about 50 or lower after 4 p.m. (Figure 6-2). Bicycle usage followed a similar pattern, with 50–60 cyclists during peak hours and roughly 30/hour during mid-day. These patterns may reflect students traveling to and from class at the University. The fluctuations in the number of joggers may be attributable to when students are not in class.

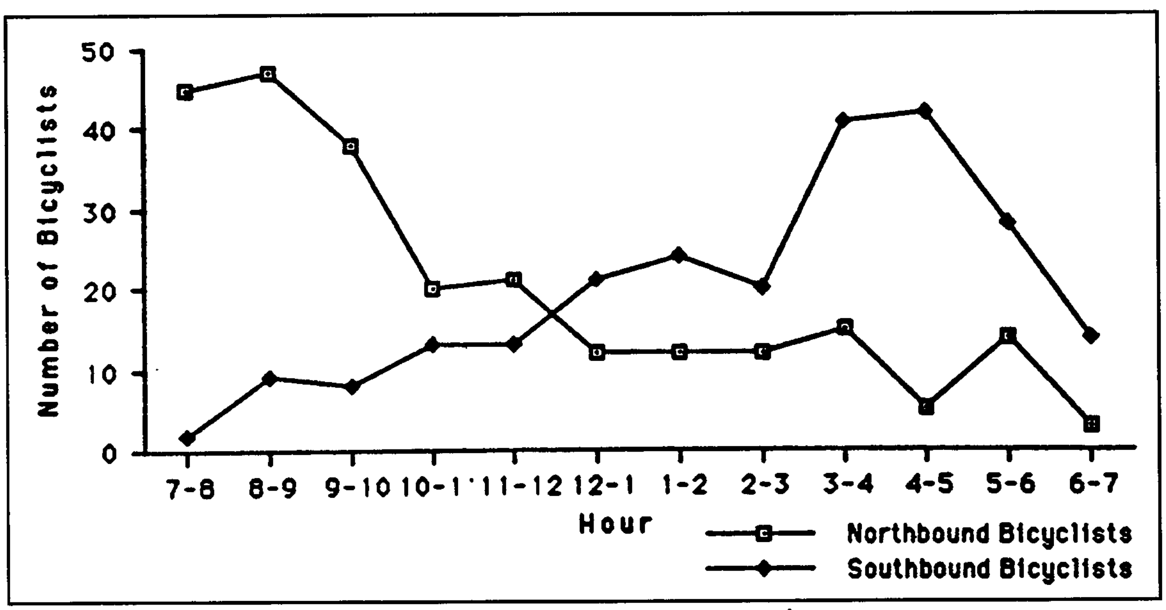
In the morning, most bicyclists are traveling northbound, to campus (Figure 6-3). Over 40 northbound cyclists per hour were counted between 7 a.m. and 9 a.m. During the afternoon, most bicyclists are traveling southbound, away from campus. About 40 southbound cyclists per hour were counted between 3 p.m. and 5 p.m.

Figure 6-2. General use breakdown by hour, Western Boulevard location.



Source: Greenways, Inc. (1992).

Figure 6-3. Travel direction of all bicyclists by hour, Western Boulevard location.



Source: Greenways, Inc. (1992).

CHAPTER 7. BICYCLING AND WALKING MODE SHARE

Introduction

The final topic covered under this exploratory search for trip generation data deals with bicycling and walking mode share. The first three reports that are discussed cover multiple cities within the United States. The section concludes with detailed descriptions of studies from Boulder, Colorado, and Portland, Oregon.

Site Descriptions

United States Cities

The Comsis Corporation and the Institute of Transportation Engineers (1993) recently prepared a comprehensive reference on travel demand management (TDM). In Part 1, the authors provide an overview of what TDM is and how TDM measures can be implemented successfully.

The second part of the report is an inventory and review of 11 TDM measures, which are classified as 1) improved alternatives to the single occupant vehicle, 2) incentives and disincentives, and 3) alternative work arrangements. Among the alternatives to the single-occupant vehicle are bicycle and pedestrian facilities. The authors state that bicycling and walking can serve as primary modes of transportation to a destination, a feeder connecting with another mode, and as circulation at a destination.

The 1990 Nationwide Personal Transportation Study involved a sample of over 22,000 households with over 48,000 members (Hu, 1991). Respondents were asked to provide information on all trips that they made in a 24-hour period.

Table 7-1 presents the rates of bicycling and walking by trip purpose and urban setting. In all cases, commuting was least likely to have been done by walking or bicycling (1.6 percent – 13.6 percent, depending on type of location), whereas social and recreational trips were most likely to have been done by walking or bicycling (8.2 – 23.6 percent). People living in central cities were usually 1.5 to 3 times more likely to walk or ride bicycles than people living in the suburbs. The levels of bicycling and walking were usually similar between smaller urban areas and larger urban areas without rail transit. Residents in urban areas with rail transit were much more likely to walk or bike than residents in urban areas without rail transit, especially for commuting. For instance, 13.2 percent of people who lived in central cities with rail commuted by walking, compared with only 3.3 percent of those living in urban areas with a population exceeding 1 million without rail transit or in smaller urban areas.

Table 7-1. Rates of bicycle and walking for major trip purposes.

Percent of Daily Person Trips by Purpose and Mode						
	Urban Areas < 1 million		Urban Areas > 1 Million *(No Rail Transit)*		Residence Areas > 1 Million *(With Rail Transit)*	
Trip Purpose/Mode	Residential in Central City	Residence in Suburb	Residence in Central City	Residence in Suburb	Residence in Central City	Residence in Suburb
Commuting	19.5%	20.5%	21.1%	20.5%	22.2%	22.4%
Private Vehicle	93.6%	98.6%	92.2%	96.8%	66.0%	88.7%
Transit	2.0	1.0	3.8	1.1	19.0%	6.0
Walking	3.3	1.6	3.3	1.7	13.2	4.5
Bicycle	0.6	0.01	0.6	0.3	0.4	0.2
Other	0.5	0.6	0.1	0.1	1.4	0.6
Shopping	41.6%	39.7%	42.6%	41.3%	39.1%	41.3%
Private Vehicle	93.4%	97.2%	92.7%	94.8%	71.6%	92.9%
Transit	1.0	0.5	1.1	0.7	4.2	0.7
Walking	5.1	1.7	5.6	3.6	22.5	6.0
Bicycle	0.3	0.4	0.4	0.4	0.8	0.2
Other	0.2	0.2	0.2	0.5	0.9	0.2
Social/Recreation	25.8%	25.1%	23.5%	25.2%	24.5%	24.8%
Private Vehicle	86.9	90.5%	84.8%	88.6%	67.9%	87.6%
Transit	0.6	0.2	1.1	0.6	6.8	1.0
Walking	10.6	7.1	12.0	8.3	21.6	9.4
Bicycle	1.6	1.1	1.7	1.7	2.0	1.6
Other	0.3	1.1	0.4	0.8	1.7	0.4

Source: 1990 National Personal Transportation Study, as reported by Comsis Corporation (1993).

The levels of bicycling and walking vary according to trip purpose (Tables 7-2 and 7-3). Commuting comprised about 7–9 percent of all walking trips in smaller urban areas and in larger urban areas without rail transit, as compared to 13–14 percent in areas with rail. Most walking trips in smaller urban areas were of comparable length (0.7 – 0.8 mile). In larger areas with rail transit, walking trips for commuting were nearly twice as long as walking trips for other purposes (1.0 – 1.1 vs. 0.6 miles). The biggest proportion (35–48 percent) of walking trips in smaller areas and in larger areas without rail was for social and recreational purposes. In areas with rail, the most common walking trip purpose was shopping/personal. For bicycling trips, social/recreation was the most likely purpose for all types of locations (44 to 65 percent). Commuting comprised 9 percent of bicycling trips for people living in central cities with rail but was actually a higher proportion of bicycling trips in other central cities. Average trip lengths did not follow any discernible patterns but were generally 1–3 miles.

The authors mention the Harris poll cited in Chapter 3 which found that 23.1 percent of those with annual incomes of $7,500 or less commute by bicycle. Bicycle commuting becomes less prevalent with increasing income. Only 1.1 percent of people with incomes of $35,001 to $50,000 commute by bicycle.

The discussion of bicycling and walking then summarizes programs in Davis, Boulder, and Portland (Oregon) and bicycle and pedestrian linkages with transit. The authors estimate that increasing the share of walking or bicycling relative to all commute trips by 5 percent would reduce the grand total of all trips by 0.9 percent and the grand total of vehicle miles traveled by 0.2 – 0.4 percent.

According to a case study prepared by Goldsmith (1992) for the National Bicycling and Walking

Table 7-2. Bicycle utilization rates in urban areas of different size.

Percent of Bicycle Trips by Purpose *(Average Trip Length in Parentheses)*						
	Urban Areas < 1 million		**Urban Areas > 1 Million *(No Rail Transit)***		**Residence Areas > 1 Million *(With Rail Transit)***	
Trip Purpose/Mode	**Residential in Central City**	**Residence in Suburb**	**Residence in Central City**	**Residence in Suburb**	**Residence in Central City**	**Residence in Suburb**
Commuting	13.8% (2.6 mil)	0.2% (2.0 mi.)	15.5% (1.8 mi.)	9.2% (2.1 mi.)	9.4% (1.2 mi.)	6.5% (2.1 mi.)
Shopping/Personal	13.6% (2.2 mi.)	24.6% (2.4 mi.)	18.0% (1.7 mi.)	23.5% (0.5 mi.)	31.2% (0.6 mi.)	11.6% (1.1 mi.)
Social/Recreation	49.2% (1.4 mi.)	43.9% (3.8 mi.)	48.2% (1.2 mi.)	56.9% (2.2 mi.)	50.3% (2.5 mi.)	64.7% (2.7 mi.)
Other	23.4% (1.3 mi.)	31.3% (0.5 mi.)	18.3% (1.1 mi.)	10.4% (0.9 mi.)	9.1% (0.5 mi.)	17.2% (0.9 mi.)

Source: 1990 National Personal Transportation Study, as reported by Comsis Corporation (1993).

Table 7-3. Walking rates in urban areas of different size.

Percent of Walk Trips by Trip Purpose *(Average Trip Length in Parentheses)*						
	Urban Areas < 1 million		**Urban Areas > 1 Million *(No Rail Transit)***		**Residence Areas > 1 Million *(With Rail Transit)***	
Trip Purpose/Mode	**Residential in Central City**	**Residence in Suburb**	**Residence in Central City**	**Residence in Suburb**	**Residence in Central City**	**Residence in Suburb**
Commuting	9.0% (0.7 mil)	8.8% (0.8 mi.)	8.7% (0.9 mi.)	6.6% (1.1 mi.)	13.8% (1.0 mi.)	13.4% (1.1 mi.)
Shopping/ Personal	29.6% (0.5 mi.)	17.6% (0.8 mi.)	29.8% (0.6 mi.)	28.4% (0.5 mi.)	41.5% (0.6 mi.)	32.8% (0.6 mi.)
Social/Recreation	38.5% (0.7 mi.)	47.9% (0.8 mi.)	35.4% (0.8 mi.)	40.2% (0.6 mi.)	25.0% (0.6 mi.)	30.9% (0.6 mi.)
Other	22.9% (0.7 mi.)	25.7% (0.8 mi.)	26.1% (0.7 mi.)	24.8% (0.4 mi.)	19.7% (0.6 mi.)	22.9% (0.6 mi.)

Source: 1990 National Personal Transportation Study, as reported by Comsis Corporation (1993).

Study, an individual¿¿s decision to bicycle or walk is influenced by both subjective factors (such as convenience or attitudes and values) and objective environmental and infrastructural factors (such as climate and the availability of facilities). The first chapter of this case study presents the results of surveys in which respondents identified reasons they do or do not cycle or walk and what inducements would encourage more bicycling and walking.

A crosssection of 20 cities across the U.S. appears in Table 7-4. The cities with the highest rates of bicycle commuting were all university towns: Davis – 25 percent; Madison – 11.0 percent; Gainesville – 10.0 percent; Boulder – 9.3 percent; and Eugene – 8.0 percent. Larger cities in terms of land area or population tended to have lower levels of bicycle commuting (Figures 7-1 and 7-2; Table 7-5). The rate of bicycle commuting in university towns was 7 times higher than in medium-sized cities and 10 times higher than in large cities. Goldsmith analyzes this finding in terms of commuting distance and bikeway mileage. Commuting distances tended to be shorter in university towns. Most cyclists in Davis, Madison, and Boulder commuted under 5 miles. The ratio of bike lane mileage to lane miles of arterials was eight times higher in university towns than in the other cities.

This case study does not contain information on trip generation or actual counts for bicycling and walking — perhaps cyclist and pedestrian counts were not available. Most of the discussion centers on bicycling because data on levels of walking were much more limited. In fact, none of the 20 cities profiled had carried out studies and surveys solely to access the role of walking in their transportation systems.

Calthorpe Associates (1992) summarized four studies of the relationship between neighborhood development patterns and travel behavior. According to 1980 data collected in the San Francisco Bay Area, 17 percent of trips generated by transit-oriented developments and traditional residential neighborhoods were made by walking (Peers, et al., 1992). The bicycle/other mode shares were 9 percent and 2 percent. In suburban tract developments, 8 percent of trips were made by walking, and 3 percent were bike/other. A second study modeled travel in traditional neighborhood and conventional suburban developments (Kulash, 1990). It found that internal motor vehicle miles traveled in traditional developments was only 57 percent that of conventional developments due to the mix of land uses and interconnected streets. In the third study, Peers (1992) found a 7 percent mode split for walking and bicycling in a typical suburban community vs. 26 percent in a suburban village center and 57 percent in a traditional Philadelphia (PA) neighborhood. The fourth study compared motor vehicle miles traveled in Rockridge, California (traditional mixed-use development) and nearby San Ramon, California (standard suburban development) (Holtzclaw, 1991). Annual vehicle miles traveled in Rockridge were nearly 50 percent lower than in San Ramon.

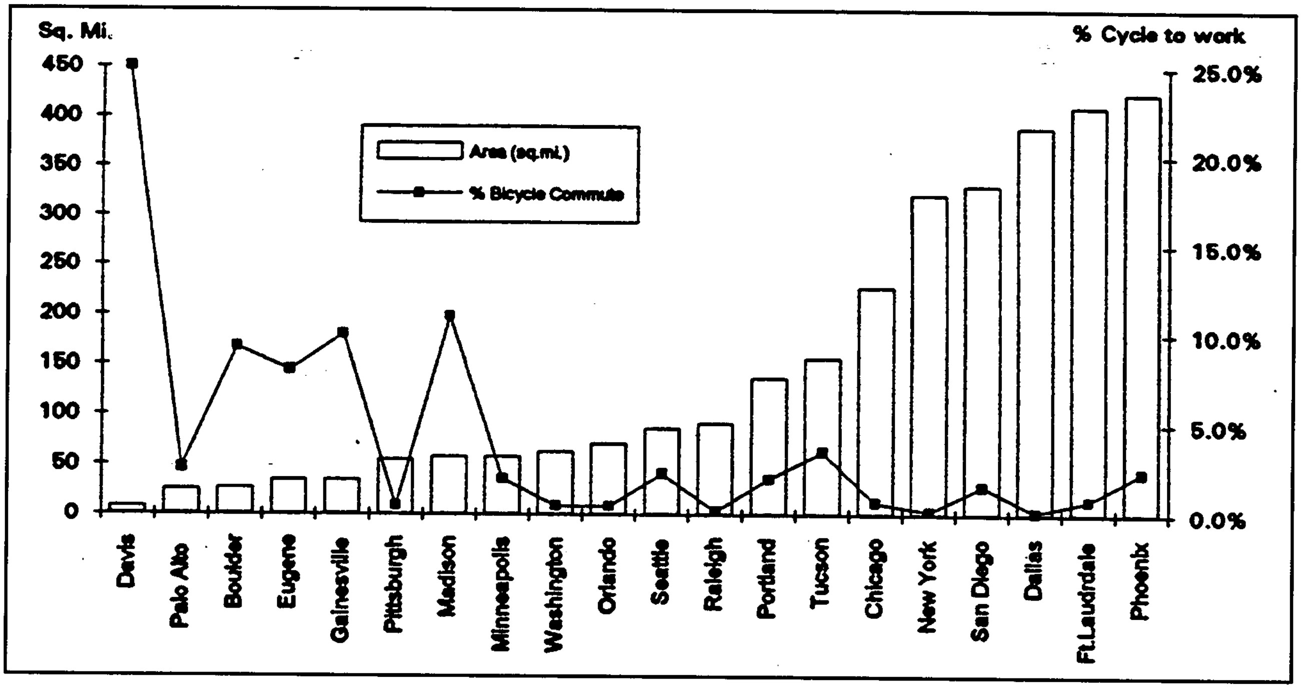
In a paper presented at the 73rd annual meeting of the Transportation Research Board, Frank (1994) analyzed data on travel behavior, population,

Table 7-4. Bicycling commuting and environmental factors in cities across the United States.

	Davis	Palo Alto	Boulder	Eugene	Gainesville	Orlando	Madison	Raleigh	Minneapolis	Pittsburgh
Population	55,000	56,000	80,000	106,000	140,000	166,000	190,000	212,000	358,000	370,000
Area (sq.mi.)	8	25	27	35	35	71	58	91	58	55
Pop. Density	6,875	2,240	2,985	3,029	4,000	2,338	3,276	2,330	6,172	6,727
Mean High Temperature	73.7	69.0	65.3	63.3	81.4	82.8	56.1	70.3	54.2	69.9
Days 0.1"+ Precipitation	47	38	51	138	75	116	118	112	114	153
Terrain	Flat	Flat	Mostly flat	Flat +hills	Flat	Flat	Flat + hills	Mildly hilly	Flat	Rolling hills
Total Mi's.Bikeway	56	42	39	60	102	5	33	50	46	20
Mi Bike Lane	31	35	14	38	75	0	13	10	6	10
Mi Bike Paths	25	7	25	22	0	5	20	40	40	10
Bike path/Bikeway Miles	0.45	0.17	0.64	0.37	0.00	1.00	0.61	0.80	0.87	0.50
Mi's of Street	106	N/A	280	427	400	430	587	806	1,078	800
Arterial/Collector Miles	33	N/A	116	126	125	N/A	210	N/A	306	248
Mi's Bkwy/Mi Street	0.528	N/A	0.139	0.141	0.255	0.012	0.056	0.062	0.043	0.025
Mi.Bkwy per Sq.Mi.	7.0	1.7	1.5	1.7	2.9	0.1	0.6	0.5	0.8	0.4
Mi's Bklane/Mi Arterial	0.939	N/A	0.121	0.302	0.600	0.000	0.062	N/A	0.020	0.040
Avg. Commute	3.0	11.0	5.1	4.0	4.0	12.0	7.2	N/A	7.0	6.0
% Commute < 5 miles	68.0%	N/A	77.0%	N/A	N/A	22.0%	56.0%	N/A	35.0%	N/A
% Bicycle Commute	25.0%	2.6%	9.3%	8.0%	10.0%	0.5%	11.0%	0.2%	2.0%	0.5%
	Tucson	Portland	Seattle	Washington	Phoenix	Dallas	San Diego	Ft.Lauderdale	Chicago	New York
Population	403,000	435,000	516,000	628,000	1,000,000	1,000,000	1,000,000	1,300,000	2,800,000	7,300,000
Area (sq.mi.)	156	137	86	63	424	390	331	411	228	322
Pop. Density	2,583	3,175	6,000	9,968	2,358	2,564	3,021	3,163	12,281	22,671
Mean High Temperature	81.7	62.0	59.7	66.4	85.0	76.9	70.5	83.5	58.7	62.2
Days 0.1"+ precipitation	52	149	158	112	35	78	43	80	126	121
Terrain	Flat to rolling	Some hills	Hilly	Flat	Flat	Flat	Flat	Flat	Flat	Flat
Total Mi's.Bikeway	73	76	54	44	59	42	113	33	18	94
Mi Bike Lane	67	40	15	2	59	0	93	17	0	45
Mi Bike Paths	6	36	39	42	0	42	20	16	18	49
Bike path/Bikeway Mi's	0.08	0.47	0.72	0.95	0.00	1.00	0.18	0.48	1.00	0.52
Mi's of Street	1,751	2,092	1,394	1,102	3,802	6000	2,519	3,900	3,676	5,585
Arterial/Collector Miles	509	490	477	433	977	N/A	711	834	989	2172
Mi's Bkwy/Mi Street	0.042	0.036	0.039	0.040	0.016	0.007	0.045	0.008	0.005	0.017
Mi.Bkwy per Sq.Mi.	0.5	0.6	0.6	0.7	0.1	0.1	0.3	0.1	0.1	0.3
Mi's Bklane/Mi Arterial	0.132	0.082	0.031	0.005	0.060	0.000	0.131	0.020	0.000	0.021
Avg. Commute	10.6	6.6	9.0	8.5	9.0	N/A	10.6	8.0	12.6	N/A
% Commute < 5 miles	32.0%	40.0%	40.0%	N/A	34.7%	N/A	32.0%	N/A	40.0%	16.0%
% Bicycle Commute	3.5%	2.0%	2.3%	0.5%	2.4%	0.2%	1.6%	0.8%	0.7%	0.2%

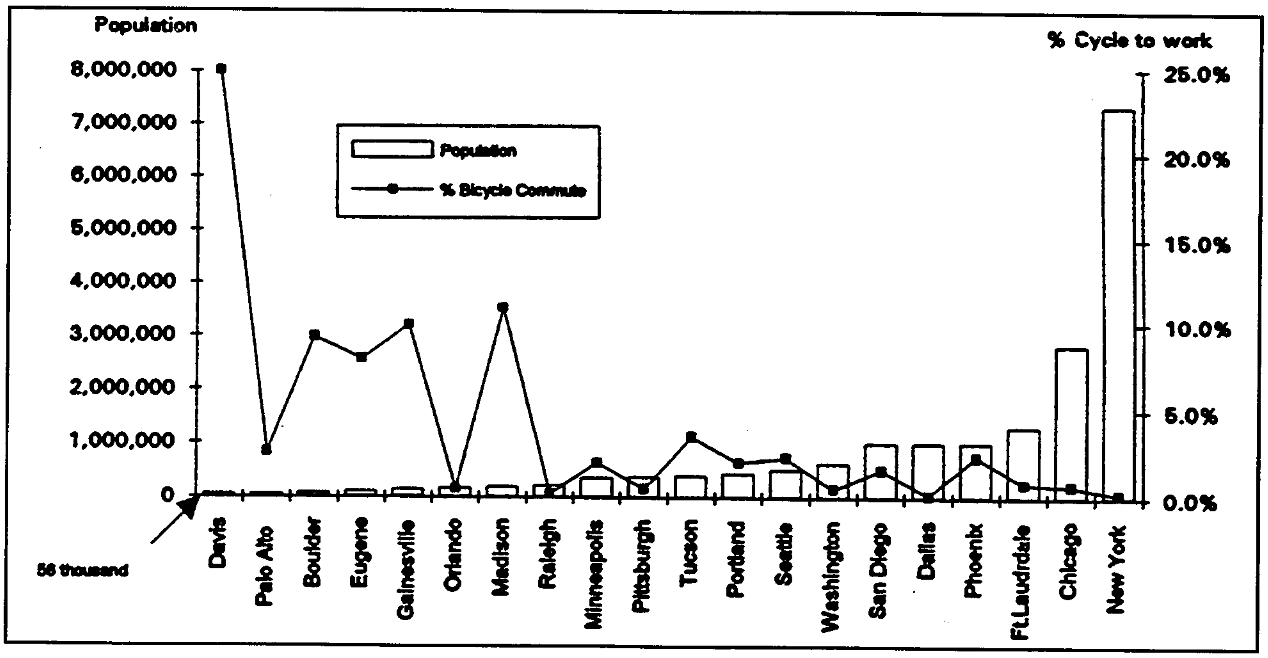
Source: Goldsmith (1992).

Figure 7-1. Size of urban area vs. percentage of bicycle commuting.



Source: Goldsmith (1992).

Figure 7-2. Population of urban area vs. percentage of bicycle commuting.



Source: Goldsmith (1992)

Table 7-5. Key bicycle commuting variables by city type.

	University towns	Medium Cities	Large cities
Population	114,200	386,000	2,400,000
Area (sq.mi.)	33	90	351
Pop. Density	4,033	4,912	7,676
Bikeways: Total Miles	58	46	58
# Miles Bike Lane	34	19	36
# Miles Bike Paths	18	27	24
# Bike path/Bikeway Miles	0.41	0.68	0.53
Miles of Street	360	1,182	4,247
Arterial/Collector Miles	122	356	1,229
Miles Bikeway/Street	0.224	0.199	0.016
Miles Bkwy per Sq.Mi.	2.7	0.5	0.2
Miles Bklane/Arterial Mi	0.405	0.044	0.039
Avg. Commute (all modes)	4.7	9.0	10.1
% Commute < 5 miles	67.0%	33.8%	30.7%
% Bicycle Commute	10.6%	1.4%	1.0%

Source: Goldsmith (1992).

employment, land use density, and land use mix for Seattle, Washington, and vicinity. He found that:

1. For work trips, employment density, population density, and land use mix were all significantly associated with percent of walking trips.
2. For shopping trips, employment density and population density were significantly associated with percent of walking trips.
3. Employment density at both trip origin and destination explained more of the variations in the modal split for walking than employment density at either trip end measured separately.
4. For both work and shopping trips, the relationships between employment density and the modal share of walking, and between population density and walking, were non-linear.

<u>Boulder, Colorado</u>

The City of Boulder has a population of 83,000, which includes about 20,000 students from the University of Colorado. Boulder has long been known for activities to promote both bicycling and walking. A variety of travel surveys has been undertaken in recent years, primarily designed to determine if programs to reduce travel by single occupant vehicles (SOV) are effective. These surveys are highlighted below. Instead of obtaining counts of bicyclists and pedestrians on a given facility, the surveys have focused on modal choice.

"<u>The 1990 Diary Study of Modal Split in Boulder Valley</u>." A stratified sample of approximately 5,560 households was invited to participate in this study, whereby participants kept a diary of their trips for one randomly assigned day during mid-September 1990. Definition of a trip was "any one-way travel from one point to another that takes you further than one city block (about 200 yards) from the original location." Information requested for each trip included the origin and destination, start and end times, purpose of the trip, and mode used. Some 1,332 diaries were returned for analysis.

Table 7-6 from the report shows the modal split for Boulder Valley. Overall, bicyclists and pedestrians accounted for 27.7 percent of all trips and 7.7 percent of all miles.

Table 7-7 shows the modal split for the work commute. Here bicyclists and pedestrians accounted for 19.8 percent of all trips and 5.5 percent of all miles. In like fashion, Table 7-8 shows the modal split for the commute to school by the approximately 20,000 University of Colorado students. Travel by bicycle or foot is considerably higher for this group, accounting for 67.2 percent of all trips and 24.2 percent of all miles, probably because many students do not own cars and parking is likely to be scarce on campus.

Table 7-6. Modal split for Boulder Valley: Fall 1990.

Travel Mode	% Trips	% Miles
Single-Occupancy Vehicle	42.9	49.3
Multiple-Occupancy Vehicle	25.7	37.0
Foot	19.1	3.2
Bicycle	8.6	4.5
Transit	1.7	4.1
Truck	0.9	1.2
School Bus	0.7	0.3
Motorcycle	0.4	0.5
Total	100.0 N_{trips} = 7334	100.0 N_{miles} = 29390

Source: Miller and Miller (February 1991).

Other interesting facts for all respondents included the following:

- Mean trip length by bicycle was 2.1 miles with standard deviation of 3.0.
- Mean trip length by foot was 0.7 miles with standard deviation of 0.6.
- Mean time spent on trip for bicyclists was 15.0 minutes with standard deviation of 12.7.
- Mean time spent on trip for pedestrians was 14.3 minutes with standard deviation of 11.7.
- Bicyclists averaged 8.0 miles per hour with standard deviation of 4.7.
- Pedestrians averaged 3.3 miles per hour with standard deviation of 2.1.

Table 7-7. Modal split for work commute.

Travel Mode	% Trips	% Miles
Single-Occupancy Vehicle	65.2	72.3
Multiple-Occupancy Vehicle	9.4	9.4
Walk	10.5	1.5
Bicycle	9.3	4.0
Transit	3.8	11.4
Truck	1.2	0.6
Motorcycle	0.7	0.7
Total	100.0 N_{trips} = 1254	100.0 N_{miles} = 6370

Source: Miller and Miller (February 1991).

Table 7-8. Modal split for school commute.

Travel Mode	% Trips	% Miles
Single-Occupancy Vehicle	15.2	41.4
Multiple-Occupancy Vehicle	8.3	14.9
Foot	46.8	12.5
Bicycle	20.4	11.7
School Bus	5.9	5.6
Transit	2.7	12.8
Truck	0.2	0.8
Motorcycle	0.5	0.4
Total	100.0 N_{trips} = 430	100.0 N_{miles} = 788

Source: Miller and Miller (February 1991).

"The 1990-1991 Corridor Count Report." For this report, trained observers counted travel modes at 5 corridors in the city during 4 weeks of 1990-1991, one week in each season.[14] The counts were performed at peak traffic hours in the morning, midday and evening on Monday through Friday. Weekend travel was not counted. Each count lasted for 60 minutes with 30 minutes devoted to each direction of traffic in the corridor. Hence, each corridor was observed for three hours per season, one count in the morning, one count at midday, and one count in the evening. The count times were ran-

[14] The spring, summer, and fall counts were made in 1990 during the weeks of April 9, July 17, and October 15, respectively. The winter count was performed the week of February 4, 1991.

domly distributed over the year so that no corridor would be counted twice on the same day at the same time.

The study was implemented to provide baseline traffic data for specific heavily traveled corridors in the city. Unlike the 1990 Diary Study, this study was not intended to be representative of the modal split of the entire city. These counts were designed to augment the diary study by providing some street-side observational data which could be tracked over years to find specific instances where the city's programs to reduce single-occupancy vehicle travel are having an effect. The study will run every year to provide the city staff and council with information on how modal split is changing at the various corridors.

Most of the data in the study refer to mode split defined by the number of modes. Table 7-9 from the report shows that 71 percent of the modes traveling along the selected corridors were single occupancy vehicles, and that bicyclists and pedestrians each accounted for 5 percent of the modes. There was some variation by corridor. All of the corridors chosen but one contained bike lanes or bike/pedestrian paths.

Season of the year had little effect on mode choice. Rainy weather tended to reduce bicycle and pedestrian travel by 2–3 percent. Bike and pedestrian travel was relatively unchanged by time of day. Day of week was a bit more varied, with Thursday yielding the most travel by bicyclists and pedestrians at 7 percent each.

Table 7-9. Modal split from Boulder corridor counts.

Travel Mode	% of Modes
Single-Occupancy Vehicle	71
Multiple-Occupancy Vehicle	17
Bicycle	05
Foot	05
High-occupancy vehicle	01
Truck	01
Total	100.0

Source: Miller and Miller (1991).

The 1990 Boulder Diary Study developed estimates of percent of trips by mode based on a 24-hour trip diary during mid-September. The corridor counts obtained in the current study were weighted to approximate modal split based on trips. Table 7-10 from the report shows the comparison. In the diary study, bicycling and walking trips accounted for a total of 28 percent of the trips, as opposed to 4 percent in the corridor study. The diary study included all trips, whether to work or a walking trip to a nearby neighborhood house. The corridor study focused on heavily traveled areas of the city and, for example, did not include any student trips around the University campus.

Table 7-10. Modal split of trips from the corridor and diary studies.

Travel Mode	% of Trips	
	Corridor Counts	Diary Study
Single-Occupancy Vehicle	42	43
Multiple-Occupancy Vehicle	27	26
Foot	02	19
Bicycle	02	09
High-Occupancy Vehicle	26	02
Truck	01	01
Total	100	100

Source: Miller and Miller (1991).

"Boulder Valley Employee Survey Report." This particular survey was performed to better understand the travel behavior of employees who work but do not reside in the Boulder Valley. A stratified, cluster sampling procedure was used to select companies in the valley. A survey of 1,000 employees' travel behavior was completed during July – August, 1991. The responses were statistically weighted to yield a 100 percent response rate (or approximately 4–5 respondents from every company selected).

Table 7-11. Modal split of trips made for the work commute compared for 1991 Boulder Valley Employee Survey and 1990 Dairy study of Boulder Valley.

Travel Mode	% of Trips	
	BVES[1]	Diary[2]
Single-Occupancy Vehicle	73.9	65.2
Multiple-Occupancy Vehicle	12.2	9.4
Foot	3.3	10.5
Bicycle	9.0	9.3
Transit	1.6	3.8
Other	0.0	1.9
Total	100	100

1 = People who work in Boulder Valley, but may live anywhere.
2 = People who live in Boulder Valley, but may work anywhere.

Source: Miller and Miller (February 1991 and March 1992).

Table 7-11 shows the mode split for the work commute compared with the 1990 diary study reported above. Bicycle and pedestrian travel accounted for 12.3 percent of trips in the employee survey and 19.8 percent in the earlier study. Employees commuted more through single-occupant vehicle trips, most likely a reflection of longer commuter distance (56 percent of the workers actually lived in Boulder). The same tendency toward more travel is reflected in Table 7-12, which shows the modal split based on miles traveled. Bicycle and pedestrian miles combined were twice as high in the diary study.

Table 7-12. Modal split of miles traveled for the work commute compared for 1991 Boulder Valley Employee Survey and 1990 Diary Survey.

Travel Mode	% of Trips	
	BVES	Diary
Single-Occupancy Vehicle	80.8	72.3
Multiple-Occupancy Vehicle	14.9	9.4
Foot	0.3	1.5
Bicycle	2.5	4.0
Transit	1.5	11.4
Other	0.0	1.3
Total	100	100

Source: Miller and Miller (February 1991 and March 1992).

Table 7-13 shows trip length and duration data for the employee survey. The average commute trip was just less than 1 mile walking and 2.7 miles bicycling. These trip lengths were somewhat longer than those in the diary study.

Table 7-13. Mean distance and time of work commute by mode.

Travel Mode	Mean		
	Distance in Miles	Time in Minutes	Miles Per Hour
Single-Occupancy Vehicle	10.59	18.81	30.8
Multiple-Occupancy Vehicle	11.97	23.47	32.4
Foot	.99	12.28	3.7
Bicycle	2.68	13.58	11.3
Transit	9.01	21.05	14.1
Mean	9.58	18.68	27.8

Source: Miller and Miller (March 1992).

Table 7-14 reiterates this finding, showing a considerably larger percentage of pedestrian and bicycling trips for the shorter commute distances. Interestingly, for work commutes up to two miles, bicycling accounted for about 20 percent of the mode split and walking 12 percent.

Table 7-14. Modal split of the work commute by distance traveled to work.

Miles	Mode					
	SOV	MOV	Foot	Bike	Transit	Total
0-2	60.3	6.5	12.3	19.5	1.5	100
3-5	69.9	13.2	0.0	15.8	1.1	100
6-10	81.1	14.0	0.0	2.1	2.8	100
11+	83.3	14.7	0.0	0.4	1.6	100

Source: Miller and Miller (March 1992).

Over two-thirds of the respondents made at least one one-way trip during the workday in addition to the normal commute. Table 7-15 reveals that about 11 percent of these trips were made on foot or bicycle.

Table 7-15. Modes used for trips made during the workday.

Mode	Percent of Employees
SOV	71.1
MOV	17.0
Foot	6.3
Bicycle	4.6
Transit	1.1
Total	100

Source: Miller and Miller (March 1992).

About three-fourths of the respondents worked the normal Monday-Friday, daytime shift. Table 7-16 shows that travel by foot or bicycle occurs considerably more often for those who work weekends or a rotating schedule. Table 7-17 shows how trips made by foot or bicycle are indirectly proportional to income.

Table 7-16. Modal split by typical work schedule.

	Percent of Employees Choosing Mode					
Typical Work Schedule	**SOV**	**MOV**	**Foot**	**Bicycle**	**Transit**	**Total**
Monday through Friday, daytime	75.4	12.9	2.5	7.4	1.8	100
Monday through Friday, evenings	57.0	29.7	4.4	8.2	0.7	100
Weekends	36.9	9.9	38.9	14.3	0.0	100
Rotating Schedule	69.0	7.6	5.5	16.4	1.5	100

Source: Miller and Miller (March 1992).

Table 7-17. Modal split by household income.

Household Income	**Percent of Employees Choosing Mode**				
	SOV	**MOV**	**Foot**	**Bicycle**	**Transit**
Under 10,000	48.6	9.3	12.5	25.7	3.9
$10,000 - $19,999	68.2	10.6	3.9	11.6	2.0
$20,000 - $29,999	67.5	15.8	4.5	8.5	3.5
$30,000 - $39,999	74.5	15.0	2.2	7.2	0.6
$40,000 - $49,999	86.0	5.9	0.2	5.6	0.0
$50,000 - $74,999	80.7	12.3	0.1	1.5	0.7
$75,000 or Greater	86.8	6.7	0.8	3.8	0.0
Mean	73.9	12.2	3.3	9.0	1.6

Source: Miller and Miller (March 1992).

"Modal Shift in the Boulder Valley 1990 to 1992." This was a replication of the earlier, 1-day trip diary study done during mid-September 1990. Methods and analyses were the same. A stratified sample of approximately 5,950 households was invited to participate in the study, with a goal of obtaining 1,000 completed trip diaries. Eventually, 1,217 respondents provided diaries, representing a response rate of 64 percent from those who agreed to participate and 20 percent from all those contacted. Results were weighted for those groups underrepresented in the sample, including those who were male, less educated, and/or between the ages of 16–25 and over 65. The margin of error for the results was approximately +/- 2.7 percent.

Table 7-18 shows the modal shift in the percent of trips between the two surveys. Overall, SOV trips decreased by 2.1 percentage points, while bicycle trips increased 2.9 percentage points and walking trips decreased 0.9 percentage points. Table 7-19 shows counterpart values for miles of travel by mode. The gain in bicycle mileage was essentially offset by the decrease in walking mileage.

Table 7-18. Modal split of trips for Boulder Valley: 1992 and 1990.

Travel Mode	Percent Miles		Modal Shift 1992-1990
	$1992^{N=6150}$	$1990^{N=7329}$	
Single-Occupancy Vehicle	39.2	41.3	-2.1
Multiple-Occupancy Vehicle	25.5	25.8	-0.3
Foot	18.5	19.4	-0.9
Bicycle	12.7	9.8	+2.9
Transit	2.1	1.6	+0.5
Truck	0.8	0.8	0.0
School Bus	0.8	0.7	+0.1
Motorcycle	0.2	0.6	-0.4
Total	100.0	100.0	

Source: Miller and Miller (May 1993).

Table 7-19. Modal split of miles for Boulder Valley: 1992 and 1990.

Travel Mode	Percent Miles		Modal Shift 1992-1990
	1992 (N=27336)	1990 (N=27597)	
Single-Occupancy Vehicle	45.7	47.8	-2.1
Multiple-Occupancy Vehicle	37.0	37.7	-0.7
Foot	2.6	3.2	-0.6
Bicycle	5.6	4.9	+0.7
Transit	6.2	4.0	+2.2
Truck	2.2	1.3	+0.9
School Bus	0.6	0.3	+0.3
Motorcycle	0.1	0.8	-0.7
Total	100.0	100.0	

Source: Miller and Miller (May 1993).

Table 7-20 shows the mode split for work commute trips. Here SOV trips decreased by 5.4 percentage points, while bicycle and foot trips gained 4.1 and 0.8 points, respectively.

Table 7-20. Modal split for work commute trips: 1992 and 1990.

Travel Mode	Percent Trips		Modal Shift 1992-1990
	1992 (N=965)	1990 (N=1116)	
Single-Occupancy Vehicle	58.2	63.6	-5.4
Foot	10.9	10.1	+0.8
Bicycle	14.9	10.8	+4.1
Multiple-Occupancy Vehicle	9.4	9.5	-0.1
Transit	5.5	4.1	+1.4
Truck	0.9	1.0	-0.1
Motorcycle	0.2	0.9	-0.7
Total	100.0	100.0	

Source: Miller and Miller (May 1993)

Table 7-21 shows counterpart values for miles traveled by mode for the work commute. Miles by foot were unchanged, while miles by bicycle increased 2.2 percentage points.

Table 7-21. Modal split of miles for the work commute: 1992 and 1990.

Travel Mode	Percent Miles		Modal Shift 1992-1990
	1992 (N=5520)	1990 (N=5917)	
Single-Occupancy Vehicle	64.7	72.2	-7.5
Multiple-Occupancy Vehicle	9.9	9.7	+0.2
Foot	1.4	1.4	0.0
Bicycle	6.5	4.3	+2.2
Transit	15.5	11.3	+4.2
Truck	2.0	1.1	+0.9
Motorcycle	0.0	0.0	0.0
Total	100.0	100.0	

Source: Miller and Miller (May 1993).

Table 7-22 shows modal split for University of Colorado students commuting to school. While pedestrian trips decreased by 1.9 percentage points, bicycle trips increased by 6.6 percentage points.

"1993 Downtown Employee Survey." In a continuing attempt to decrease SOV trips, this survey was "conducted for two purposes: 1) to gather information on what types of incentives would be most useful in getting employees out of SOVs, and 2) to measure employee travel and parking behavior to serve as a baseline against which to compare future progress." The survey was done primarily via telephone during the last 2 weeks of September 1993. A stratified cluster sampling method was used to select companies for participation. Eventually 460 surveys were completed, representing a response rate of 68 percent of all companies contacted and a response rate of 81 percent for all employees contacted. The margin of error was approximately +/- 1 – 5 percent.

Table 7-22. Modal split for school commute: 1992 and 1990.

Travel Mode	Percent Miles		Modal Shift 1992-1990
	$1992^{N=439}$	$1990^{N=425}$	
Foot	47.9	49.8	-1.9
Bicycle	27.1	20.5	+6.6
Single-Occupancy Vehicle	10.3	13.4	-3.1
Multiple-Occupancy Vehicle	5.9	7.6	-1.7
School Bus	5.0	5.7	-0.7
Transit	3.3	2.1	+1.2
Motorcycle	0.5	0.7	-0.2
Truck	0.0	0.2	-0.2
Total	100.0	100.0	

Source: Miller and Miller (December 1993).

Table 7-23 shows the mode split for the work commute for this 1993 survey versus the 1991 Boulder Valley Employee Survey. SOV trips had decreased by 9.4 percentage points, while bicycle and walking trips had increased 2.3 and 5.4 percentage points, respectively.

About 11 percent of employees rode their bicycles to work on the survey day. Table 7-24 shows that slightly over half parked their bike at their office or place of work. Some 43 percent had a bicycle available for commuting and 25 percent did not. Thirty-two percent indicated they would not use a bicycle to commute anyway.

Table 7-23. Modal split of the work commute: downtown versus Boulder Valley employees.

Travel Mode	Percent of Employees	
	Downtown Employee Survey 1993	Boulder Valley Employees 1991
Drive Alone	64.5	73.9
Bicycle	11.3	9.0
Bus	10.5	1.6
Walk	8.7	3.3
Carpool	5.0	12.2
Total	$100^{N=459}$	$100^{N=1000}$

Source: Miller and Miller (December 1993).

Table 7-24. Where employees park when they ride to work.

Where Employee Parks Bike	Percent of Employees
Office/Place of Work	53.8
Rack Near Mall	25.0
Rail/Tree/Fence	7.7
Parking Meter	5.8
Rack at Parking Structure	5.8
Other	1.9
Total	100.0$^{N=52}$

Source: Miller and Miller (December 1993).

Table 7-25 provides information about incentives that would encourage employees to ride bicycles to work more often. Thirteen percent of the respondents mentioned more/better routes for riding.

These surveys reveal that the percentage of single-occupancy trips in Boulder has decreased since 1990. For all trips in the Boulder Valley, the modal split of bicycle trips has increased, but pedestrian trips have decreased. Boulder's activities to promote bicycling may be diverting single-occupancy vehicle trips and walking trips to bicycles.

"Bicyclist/Pedestrian Count Data." Besides the modal split studies described above, actual counts for pedestrians and bicyclists have been made in Boulder. One study was performed by Transplan Associates, Inc., and concerned traffic around the downtown Boulder mall (nicknamed the Pearl Street Mall by locals).[15] This particular mall extends over a four-block area in Old Boulder and serves as a magnet for both local and tourist traffic. The street through the center is closed to traffic, and the area is heavily landscaped and frequented by entertainers. More than 50 stores surround the pedestrian core.

Data were gathered by establishing a corridor around the mall (see Figure 7-3), and 12 intersections were used to count pedestrians and bicyclists passing through the corridor from 7 – 9 a.m. and 11 a.m. – 1 p.m. on November 8, 1993. November counts were expected to be much lower than summer counts, but a fall "snapshot" was desired as part of the Downtown Boulder Streetscaping Plan. Thirteenth Street, which runs north/south into the center of the mall, is designated as a bicycle corridor and connects to a heavily traveled separated path.

Figure 7-4 shows the number of pedestrians and bicyclists accessing the mall area by direction from 11 a.m. to 1 p.m. The total number of pedestrians crossing the corridor line was 5,765, and the total number of bicyclists was 600. Other ways of examining the counts are shown in Figures 7-5 and 7-6, which show the numbers of pedestrians and bicy-

[15]Personal correspondence from Bill Fox, Senior Associate.

Table 7-25. Incentives that would encourage employees to ride their bikes more frequently.

Incentives	Percent of Responses
None	17.7
Other Incentive[1]	13.9
Already Use Another Alternate Mode	13.5
Better/More Bike Routes	12.7
Already Ride Frequently	7.6
Relaxed Dress Codes	5.9
Showers	4.6
Increased Safety	4.6
Bike Lockers	4.2
Flexible Work Schedule	3.0
House Closer to Work	3.0
More Bike Racks	2.5
Indoor Bike Parking	2.1
Bike-Friendly Weather	2.1
Aid with Day Care Needs	1.3
Bike Racks on Buses	1.3
Total	100.0$^{N=237}$

[1]Responses in the "other" category included better bicycle, less hills, money, a vehicle for errands, less traffic, and more time.

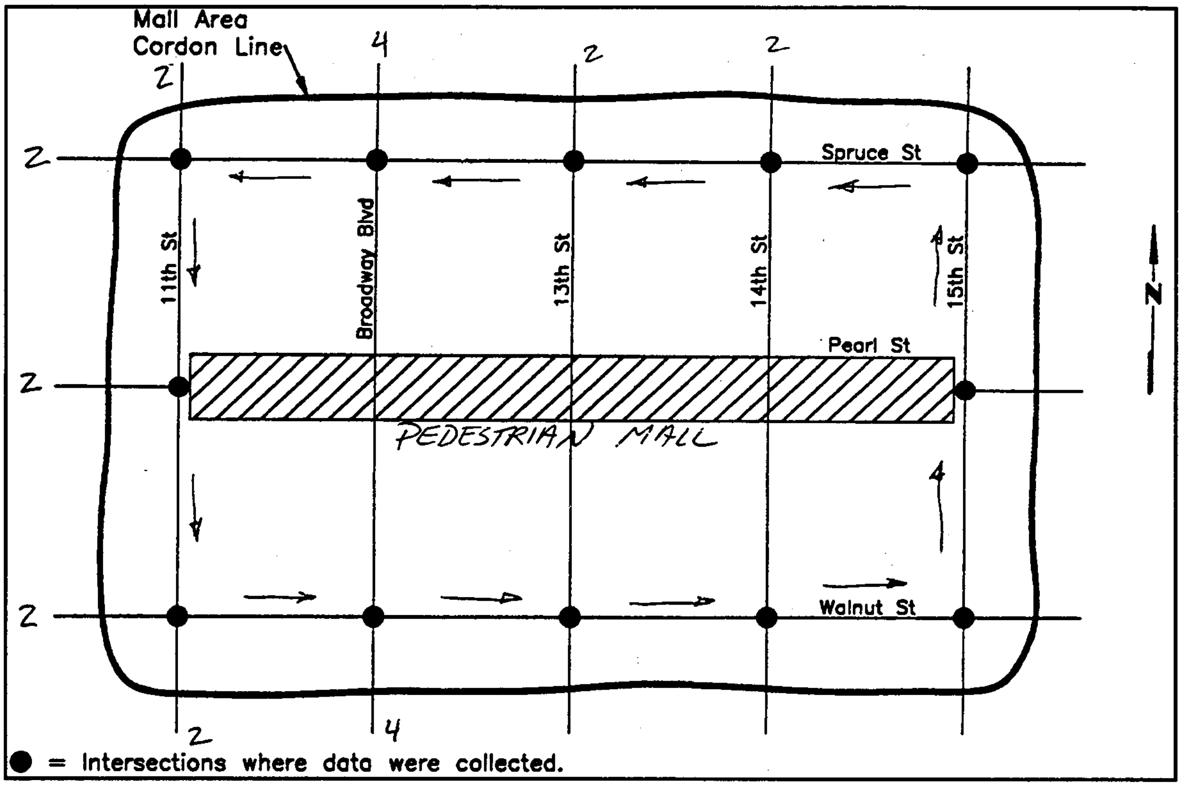
Source: Miller and Miller (December 1993).

clists at each intersection and the number of crosswalk users, respectively, during this same time period. Figures 7-7 and 7-8 are two comparisons from the 7 a.m.–9 a.m. time period. Total pedestrians and bicyclists accessing the mall area during this period were 2,830 and 355, respectively, or about half the totals observed from 11 a.m. to 1 p.m.. As a final example, Figure 7-9 shows the bicycle parking totals per block at 9 a.m.

Portland, Oregon

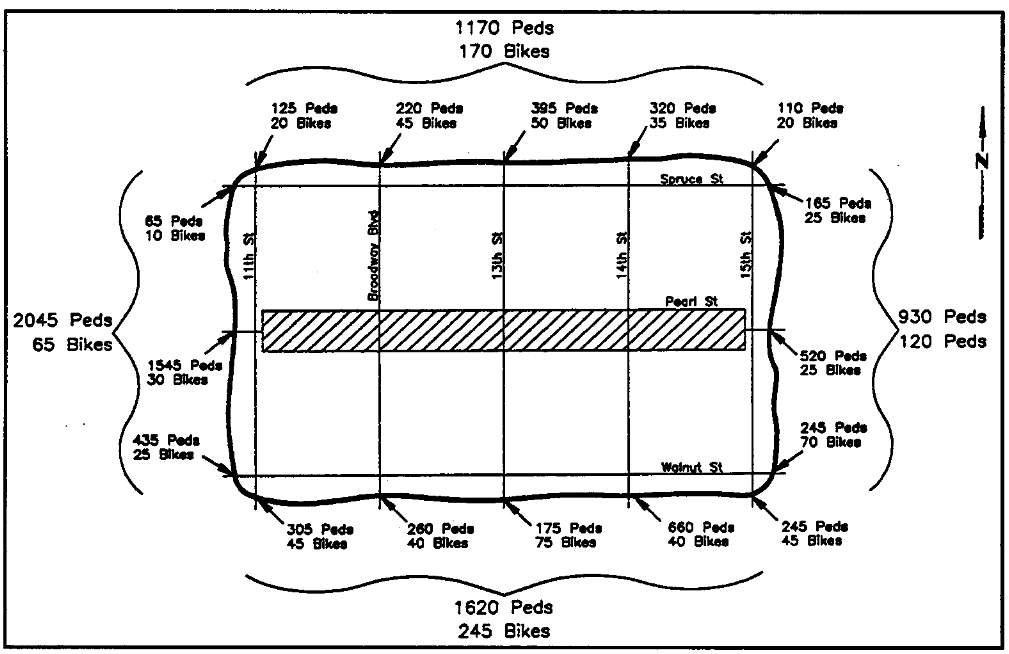
"The Pedestrian Environment" (Parsons Brinckerhoff Quade and Douglas, Inc.; Cambridge Systematics, Inc.; and Calthorpe Associates, 1993) is one of a series of reports that make up the LUTRAQ project ("Making the Land Use, Transportation Air Quality Connection"). LUTRAQ is a national demonstration project to develop methodologies for

Figure 7-3. Pedestrian and bicycle data collection, downtown Boulder, Colorado.



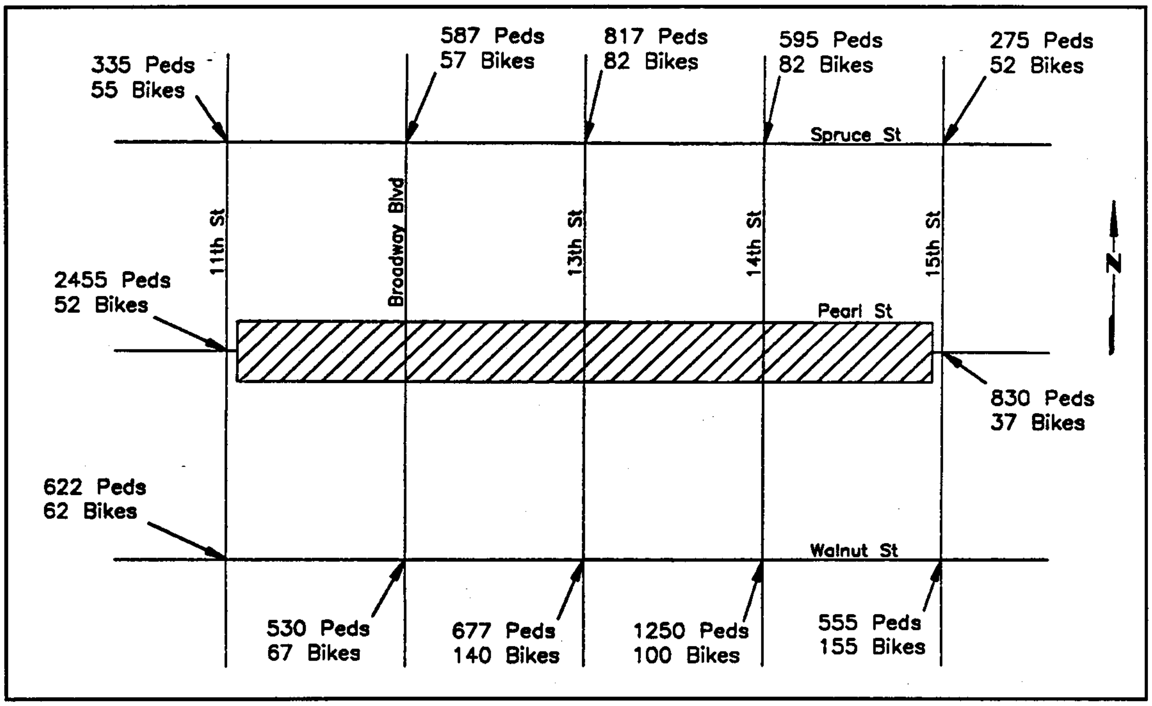
Source: Personal correspondence from Bill Fox, Senior Associate, Transplan Associates, Inc.

Figure 7-4. Pedestrians and bicyclist accessing the mall area, 11:00 a.m. to 1:00 p.m.



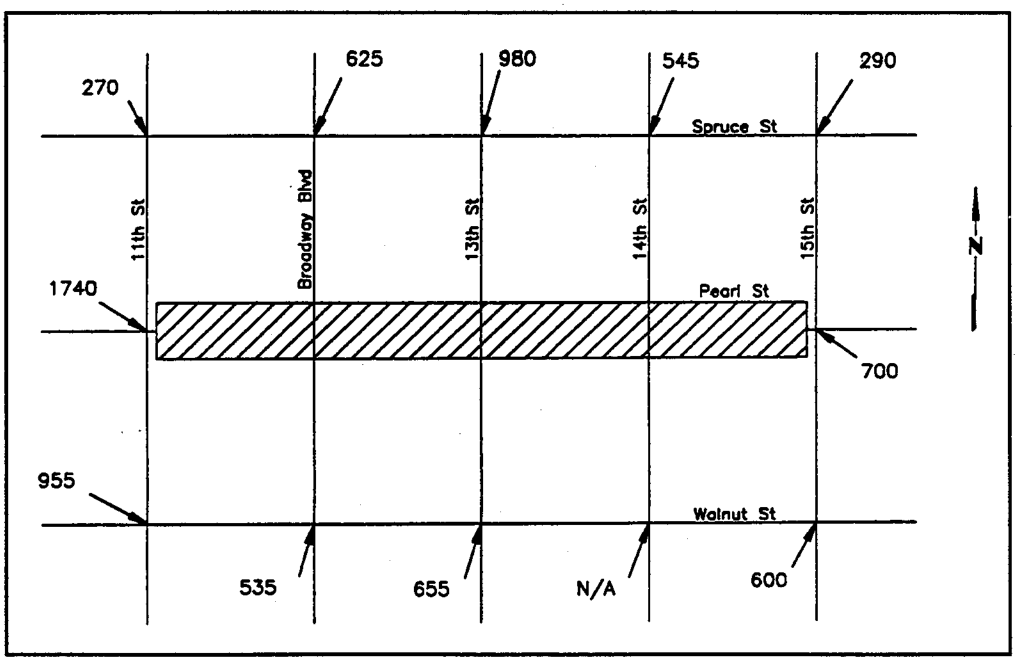
Source: Personal correspondence from Bill Fox.

Figure 7-5. Pedestrians and bicyclists observed at each intersection, 11:00 a.m. to 1:00 p.m.



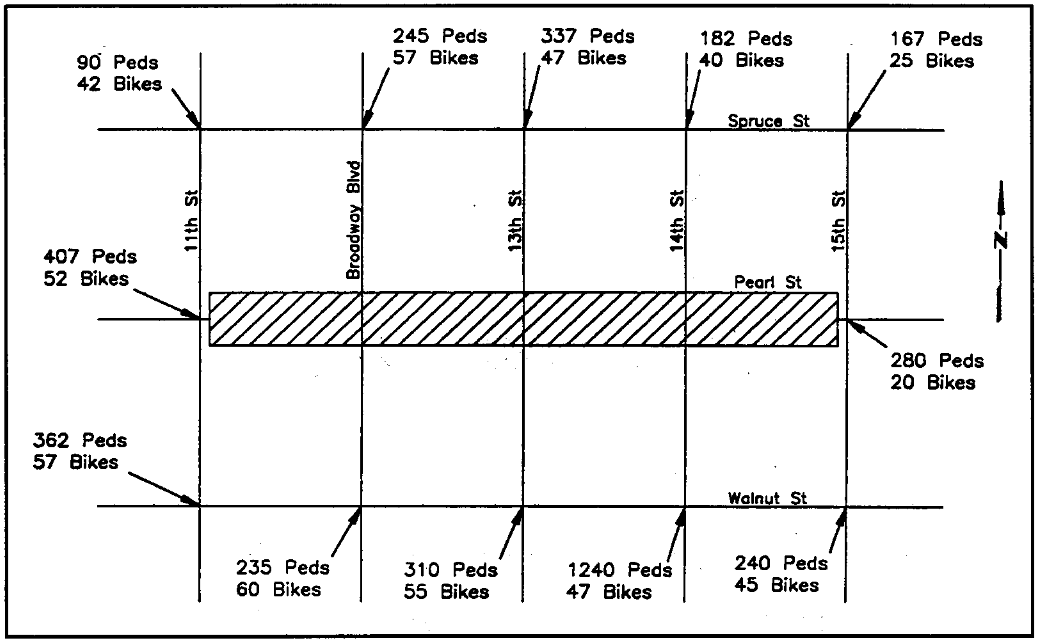
Source: Personal correspondence from Bill Fox.

Figure 7-6. Crosswalk users (sum of all crosswalks).



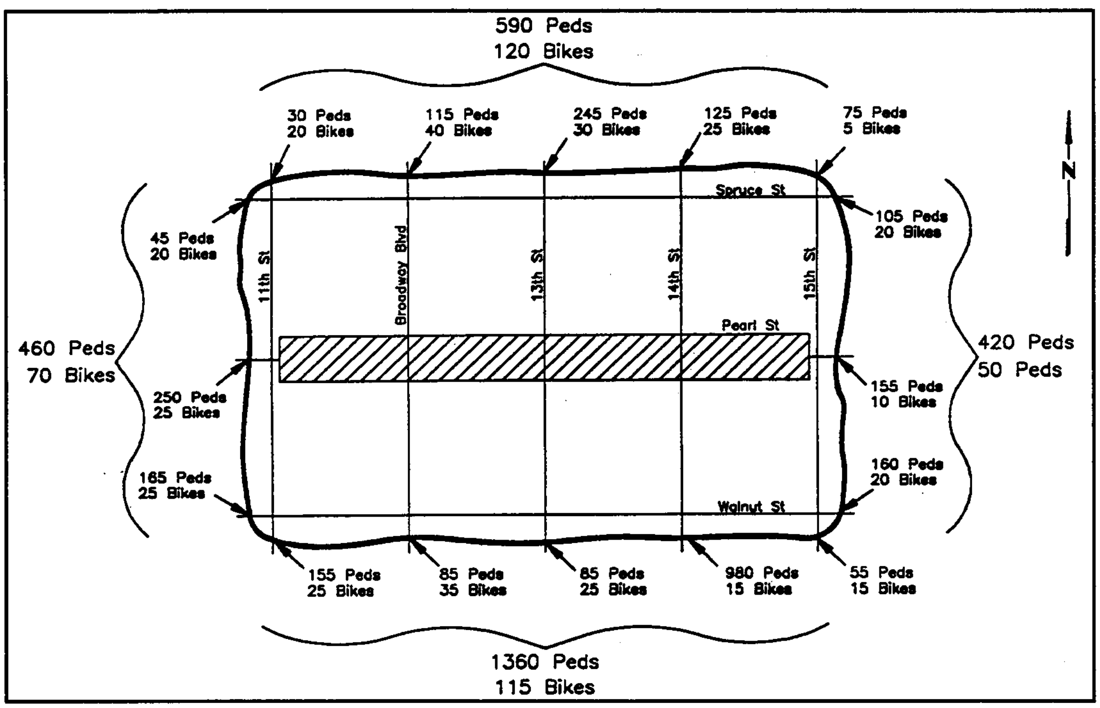
Source: Personal correspondence from Bill Fox.

Figure 7-7. Pedestrians and bicyclists observed at each intersection, 7:00 a.m. to 9:00 p.m.



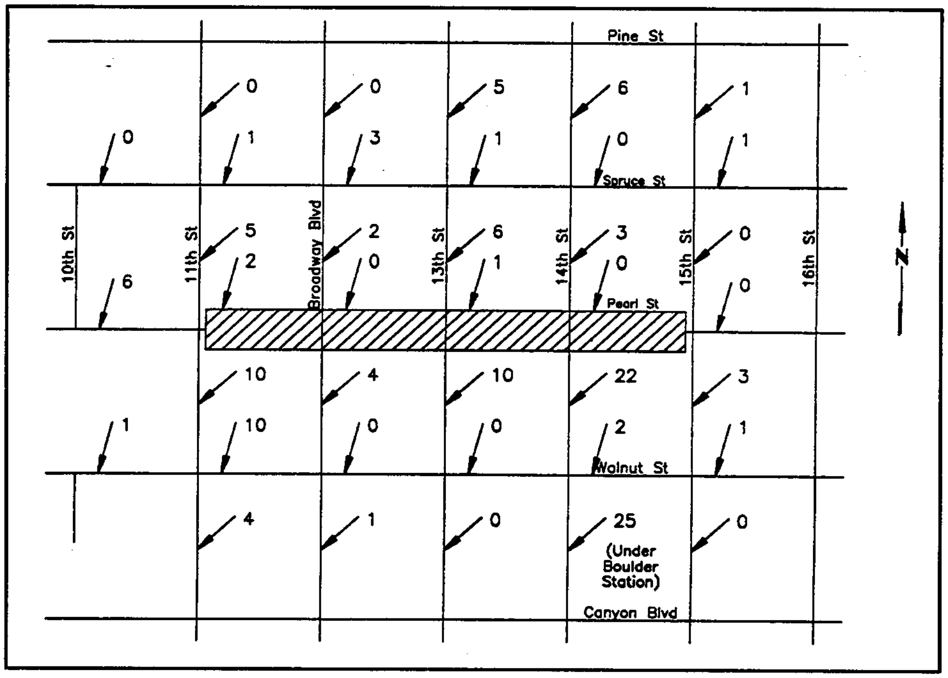
Source: Personal correspondence from Bill Fox.

Figure 7-8. Pedestrians and bicyclists accessing the mall area, 7:00 a.m. to 9:00 a.m.



Source: Personal correspondence from Bill Fox.

Figure 7-9. Bicycle parking totals per block.



Source: Personal correspondence from Bill Fox.

creating alternative suburban land use patterns and design standards and evaluating their impacts on:

- automobile dependency,
- mobility,
- air quality,
- energy consumption, and
- sense of community.

The proposed Western Bypass freeway around the Portland metropolitan region has served as a case study.

"The Pedestrian Environment" basically concerns the relationships between land use patterns and household travel behavior. Data sources include the 1985 home interview survey done by the Portland area regional government, results from regional travel forecasting models, and land use information. The major hypothesis tested was that travel behavior is directly related to neighborhood land use patterns. A key component was the Pedestrian Environmental Factor (PEF), basically a measure of pedestrian friendliness. The PEF includes the following elements:

- ease of street crossings,
- sidewalk continuity,
- local street characteristics (grid vs. cul-de-sac), and
- topography.

Project staff used the factors in the PEF to rate each of the 400 zones in the regional travel demand forecasting model network. Four was the lowest possible score and 12 the highest.

The PEF was found to be directly associated with travel mode choice (see Table 7-26 taken from the report). Households in zones with pedestrian friendly areas (the higher PEFs) were associated with more transit, bicycling, and walking trips. The tendency was even stronger when pedestrian zone categories were used to examine travel mode choice. Pedestrian zone categories were derived after studying the historical development patterns of the city. The older portions of the city tended to have a grid street pattern and relatively flat topography. The CBD received pedestrian- and transit-oriented revitalization enhancements in the 1970's. Outside of the City of Portland, the tendency is for isolated, small city centers best served by the automobile. The five pedestrian zone categories developed were

- Central business district (PEF = 12)
- City of Portland (outside CBD)—very pedestrian friendly (PEF = 12)
- City of Portland (outside BD)—pedestrian friendly (PEF = 9–11)
- Outside the City of Portland—pedestrian friendly (PEF = 9–12)
- Non-pedestrian friendly (PEF = less than 9)

Table 7-27 distributes the travel mode choice by these pedestrian zone categories and again shows the proportion of transit, bicycling, and walking trips to be directly related to the pedestrian friendliness of an area.

Two other variables also exhibited this tendency. Transit, bicycling, and walking trips increased with the number of households per acre, as well as with transit level of service, defined by the amount of employment accessible via a 30-minute or less transit trip.

Table 7-28 compares vehicle miles traveled (VMT) and vehicle trips with the PEF. Both VMT and number of vehicle trips decrease as pedestrian friendliness increases.

Linear regression models were also used to examine several variables simultaneously with household travel behavior. Table 7-29 shows how predicted household VMT would increase or decrease with changes in land use and demographic variables. A one unit increase in PEF decreases VMT by 0.7 miles, or 2.5 percent of the average daily VMT per household (28.2 miles). Table 7-30 lists measures which reduce VMT per household by 10 percent. Table 7-31 is similar to Table 7-30 and shows the predicted impact on daily household vehicle trips as land use and demographic variables change. Thus, increasing a zonal PEF from 7 to 10 would result in a 3.6 percent decrease in the daily household vehicle trips. Thus, VMT is reduced due to both shorter trip lengths and fewer vehicle trips. The following conclusions are offered:

Table 7-26. Travel mode choices by pedestrian environment factor.

PEDESTRIAN ENVIRONMENT FACTOR (PEF)	AUTO		TRANSIT		WALK/BICYCLE		OTHER		TOTAL	
4	1,308	*94.2%*	35	*2.5%*	30	*2.2%*	16	*1.2%*	1,389	*100.0%*
5	2,400	*94.7%*	59	*2.3%*	41	*1.6%*	35	*1.4%*	2,535	*100.0%*
6	2,607	*94.3%*	95	*3.4%*	38	*1.4%*	25	*0.9%*	2,765	*100.0%*
7	1,788	*91.3%*	98	*5.0%*	43	*2.2%*	30	*1.5%*	1,959	*100.0%*
8	1,103	*92.3%*	46	*3.8%*	35	*2.9%*	11	*0.9%*	1,195	*100.0%*
9	1,067	*86.7%*	96	*7.8%*	43	*3.5%*	24	*2.0%*	1,230	*100.0%*
10	771	*83.3%*	98	*10.6%*	40	*4.3%*	17	*1.8%*	926	*100.0%*
11	1,796	*76.3%*	296	*12.6%*	225	*9.6%*	37	*1.6%*	2,354	*100.0%*
12	625	*79.6%*	84	*10.7%*	58	*7.4%*	18	*2.3%*	785	*100.0%*
All	13,465	*88.9%*	907	*6.0%*	553	*3.7%*	213	*1.4%*	15,138	*100.0%*

Source: Parsons Brinckerhoff Quade and Douglas, et al. (1993).

Table 7-27. Travel mode choices by pedestrian zone category.

PEDESTRIAN ZONE CATEGORY	AUTO		TRANSIT		WALK/BICYCLE		OTHER		TOTAL	
1 (CBD. PEF=12)	112	*49.6%*	62	*27.4%*	42	*18.6%*	10	*4.4%*	226	*100.0%*
2 (In City, PEF=12)	482	*78.1%*	71	*11.5%*	48	*7.8%*	16	2.6%	617	*100.0%*
3 (In City, PEF=9-11)	3,043	*81.1%*	392	*10.5%*	262	*7.0%*	54	*1.4%*	3,751	*100.0%*
4 (Other PEF=9-12)	311	*89.9%*	23	*6.6%*	6	*1.7%*	6	*1.7%*	346	*100.0%*
5 (PEF<9)	9,517	*93.3%*	359	*3.5%*	195	*1.9%*	127	*1.2%*	10,198	*100.0%*
All	13,465	*88.9%*	907	*6.0%*	553	*3.7%*	213	*1.4%*	15,138	*100.0%*

Source: Parsons Brinckerhoff Quade and Douglas, et al. (1993).

Table 7-28. Auto usage daily VMT by pedestrian environment factor.

PEDESTRIAN ENVIRONMENT FACTOR (PEF)	VMT PER HOUSEHOLD	VMT PER PERSON	VEHICLE TRIPS PER HOUSEHOLD	VEHICLE TRIPS PER PERSON
4	38.3	16.3	6.5	2.7
5	36.7	14.4	6.1	2.4
6	32.4	13.8	5.9	2.5
7	31.3	12.8	5.8	2.4
8	26.7	11.3	5.6	2.3
9	22.3	9.7	5.1	2.2
10	21.5	9.9	5.0	2.2
11	18.1	7.9	4.5	1.9
12	18.0	8.1	4.4	2.0
Weighted Average	30.6	12.8	5.7	2.4

Source: Parsons Brinckerhoff Quade and Douglas, et al. (1993).

Table 7-29. Household VMT model predicted impacts.

CHANGE IN EXPLANATORY VARIABLE	IMPACT ON DAILY HOUSEHOLD VEHICLE MILES TRAVELED
Land Use Variables	
Unit Increase in Zonal PEF	-0.7 miles
Increase from 3 to 4 Households per Zonal Acre*	-0.5 miles
20,000 Increase in Employment Accessible by Auto in 30 Minutes	-0.5 miles
20,000 Increase in Employment Accessible by Transit in 30 Minutes	-0.6 miles
Demographic Variables	
$5,000 Increase in Household Income	0.8 miles
Unit Increase in Household Size	3.0 miles
Unit Increase in Workers per Household	1.4 miles
Unit Increase in Cars per Household	1.8 miles
Average Daily VMT per Household	*28.2 miles*

* The household density impact on VMT is linear function of the natural logarthm of household density but is an exponential function of unit changes in household density; therefore, the VMT impact tapers off for unit increases in households per acre as household density increases.

Source: Parsons Brinckerhoff Quade and Douglas, et al. (1993).

Table 7-30. Measures which reduce VMT per household 10 percent.*

- Increase the quality of the pedestrian environment from average to high (four unit increase in PEF), or
- Decrease the average number of cars per household by 1.5 cars, or
- Increase household density from 2 to 10 or 3 to 15 households per zonal acre, or
- Increase the number of jobs accessible by auto in 30 minutes by 105,000, or
- Increase the number of jobs accessible by transit in 30 minutes by 100,000.

*Approximate individual variable changes required to lower VMT by 10 percent for a household with average samples properties.

Source: Parsons Brinckerhoff Quade and Douglas, et al. (1993).

Table 7-31. Household vehicle trip model predicted impacts.

CHANGE IN EXPLANATORY VARIABLE	IMPACT ON DAILY HOUSEHOLD VEHICLE TRIPS
Land Use Variables	
Increase Zonal PEF from 4 to 7	-0.4 trips
Increase in Zonal PEF from 7 to 10*	-0.2 trips
20,000 Increase in Employment Accessible by Auto in 20 Minutes	0.1 trips
20,000 Increase in Employment Accessible by Transit in 30 Minutes	-0.1 trips
Demographic Variables	
$5,000 Increase in Household Income	0.1 trips
Unit Increase in Household Size	1.2 trips
Unit Increase in Cars per Household	0.7 trips
Average Daily Vehicle Trips per Household	5.5 trips

* The zonal PEF impact on vehicle trips is a linear function of the natural logarithm of (PEF-3) but is an exponential function of the PEF value; therefore, the vehicle trip reduction impact of a unit change in PEF tapers off as increasingly higher PEF values are reached.

Source: Parsons Brinckerhoff Quade and Douglas, et al. (1993).

1. The adequacy of the pedestrian environment is a significant factor in explaining auto use, in combination with such socioeconomic measures as household income, size, number of workers, and auto ownership rates, and such land use variables as zonal density and accessibility.
2. Travel demand and forecasting models across the United States can be enhanced by the inclusion of variables similar to those discussed above in their auto ownership, mode choice and destination choice models. The ability of these models to explain observed variations in vehicle trip generation rates and trip lengths should be improved as a result.
3. Unlike the other determinants of travel behavior, the characteristics of the built environment can be modified by public policies and investments. Streets and intersections can be made more attractive to pedestrians. Paths can be created into and through neighborhoods adjacent to arterials where transit service exists. Thus there is a sound, rational basis for public policies in Oregon and across the United States that require patterns of neighborhood and urban development supportive of non-auto travel.

CHAPTER 8. SUMMARY AND CONCLUSIONS

Summary of Trip Counts

Most of the sources of bicyclist and pedestrian counts that we uncovered pertained to specific geographical areas. Data for bicycle trips were more readily available, perhaps because bicycle advocacy groups have been more active and are more widespread. It may also be that bicycle counts can be done mechanically and are thus less labor intensive.

Bicycle Trips

As expected, bicycle counts are done by a variety of methods, for different periods of time, and with different levels of detail. Each city shown in Table 8-1 has a unique combination of counting method, facility types, and time periods. The counts are the product of these and local characteristics and may not be readily comparable.

Eugene, Oregon, and Madison, Wisconsin, both have records on temporal variations. In Eugene, volumes from one day to another, and from one month to another, both varied by a factor of about 3 (Figures 4-8 and 4-9). The more extreme winters in Madison are reflected in its counts—a 5-year January average of 80, and a 5-year June average 13 times higher at 1,069 (Table 4-12).

Manual counts are the most commonly used method among the cities shown in Table 8-1. These were limited to specified days and for blocks of time from one-half hour to 14 hours per location. Eugene, Oregon, installed a permanent detector, which counted continuously along one path. Madison, Wisconsin, also used automatic detectors which counted 24 hours a day. Questionnaires were distributed in a few cities to obtain information about bicyclists and their behavior.

Year-to-year comparisons were available in some cities. Transportation Alternatives (1992) reported that bicycles comprised 8.4 percent of mid-day traffic in midtown Manhattan in 1988, and 9.0 percent in 1992. They counted at selected intersections, each spring usually for one-half or one hour each, and aggregated the figures. The North Central Florida Regional Planning Council (1994), the New York City Department of Transportation (1992), the San Diego Association of Governments (1991), and Buckley (1982, 1991) used similar "snapshot" approaches. That is, counts were done for a number of hours on a selected day and then done at the same location in a future year at the same time of year. Although some individual locations in all four cities showed increases and others showed decreases, the aggregate of all locations counted in New York City showed a 6.5 percent increase 1980–1991 (Table 4-9). The total number of bicyclists at all sites in San Diego increased 6.9 percent between 1987 and 1990 (Table 4-8). Data for two bicycle paths in Madison show a slight downward trend 1980-1989 (Figure 4-13).

We found few sources of before-and-after data. With the installation of a bicycle lane along Anderson Road in Davis, California, there was an increase of 87 percent in the number of cyclists 25 years and older (Lott et al., 1978) (Table 4-2). Among all cyclists, Anderson Road and two other streets showed similar increases. The older cyclists were more likely to perceive the lane as an improvement in cycling conditions and thus shifted their routes onto Anderson Road. In Fort Lauderdale, Florida, bicycle traffic declined after a bicycle lane was added because the before count was taken during the peak tourist season. The Greenway Bridge in Eugene, Oregon, has generated about 1,350 bicycle trips per 5-day workweek and 1,680 trips per weekend (Lipton, 1974). Trips generated are those trips that would not have been made if the bridge had not been built. The temporary bike lanes created for a designated Bike to Work Day in Phoenix resulted in about 200 more bicycle trips than on an average weekday (Cynecki et al., 1993).

Trips on Multi-Use Trails

For several multi-use trails, we obtained detailed information, some of which is summarized in Table 8-2. More limited information was available for a number of other trails, most of which is reported in the case study by Greenways, Incorporated (1992). The counts were recorded during periods of time ranging from a few hours — 228 bicycles in a two-hour period used Rosslyn Circle in Virginia — to an entire year — an estimated 750,000 users on the Burke-Gilman Trail in Seattle. At the Western Boulevard location of the Avent Ferry Road Bicycle Path in Raleigh, NC, about 100 pedestrians and 55 bicyclists were counted during their respective peak hours (Figure 6-2). For trails where modal split data were available, most users were cyclists. Florida's St. Marks Trail, the Burke-Gilman Trail in Seattle, Rhode Island's East Bay Bicycle Facility, and the I-66/Curtis Trail in Virginia all had 80 percent or more bicyclists. On the other hand, only 20 percent of the users of the Lafayette/Moraga Trail east of San Francisco were bicyclists. Table 6-3 gives month-to-month counts for two locations along the Mount Vernon Trail in Washington, D.C. At Belle Haven, the volume in July 1989 was 17 times higher than in January 1989. At Daingerfield, the volume in October 1984 was six times higher than in January 1989.

Pedestrian Trips

As described in Chapter 6, we found pedestrian data for a number of multi-use trails. Other sources give pedestrian counts for sidewalks. Extensive block-by-block counts are reported in Pushkarev and Zupan (1975) for New York City and Soot (1990) for Chicago. In New York City hourly flow rates of up to 12,000 were found on sidewalks and 12-hour flows of 5,650 to 89,700 were found at five sidewalk locations. Figure 5-7 shows how the peaking patterns differ. In 1989, 10-hour midblock volumes in downtown Chicago ranged from less than 1,000 to over 30,000. Between 1981 and 1989, pedestrian volumes generally declined in the eastern part of downtown and increased in the western part, a reflection of shifts in retailing and office construction. Daily patterns at specific locations changed very little in the eight years. Fifteen-minute counts at selected intersections in Washington, D.C., ranged from less than 100 to over 700, depending on the location and time of day (Figures 5-2 through 5-4).

Pushkarev and Zupan present pedestrian trip counts for specific land uses, such as office buildings, restaurants, and supermarkets (Tables 5-2 through 5-5). They also derived equations to estimate the number of pedestrians along a block at any instant according to building floor space and walkway space. Their work was the only research that we found in which pedestrian counts were related to land use in similar fashion in the ITE's Trip Generation Manual.

We came across only two indications of how many pedestrian trips are generated by pedestrian facilities. Pushkarev and Zupan's equations contain walkway space as an independent variable—there are roughly three pedestrians on a block sector at any instant for every 1,000 square feet of sidewalk and plaza space on a block sector. The hourly pedestrian volume increased by 462 after a section of Fulton Street in lower Manhattan was closed to vehicular traffic.[16]

We did not find anything about how many trips would not have been made by walking if a trail or other facility were not in place. The research that

[16] Personal correspondence from Glynis Berry, Director, New York City Department of Transportation Pedestrian Projects Group.

we reviewed did not address the question of how many walking trips were diverted from alternative routes by the facility.

Modal Split

The 1990 Nationwide Personal Transportation Study obtained modal splits for bicycling and walking at the national level (Table 7-1). Walking was usually 5–10 times more prevalent than bicycling. In fact, over 20 percent of shopping and social/recreation trips in large cities with rail transit were made by walking. While fewer than 1 percent of commuting trips nationwide were made by bicycle, several cities reported bicycle commuting rates or mode shares over 5 percent (Table 5-4).

We received more detailed data from Boulder, Colorado. According to travel diaries, walking accounted for 19.1 percent of all trips and bicycling for 8.6 percent (Table 7-6). For student trips to the University of Colorado, two-thirds were made by foot or bicycle (Table 7-8). As shown in Figure 7-4, 5,765 pedestrians and 600 cyclists entered the downtown mall area between 11:00 AM and 1:00 PM. Along individual streets, 65 to 1,545 pedestrians were counted and 20 to 75 bicycles. Ninety-eight percent of the trips entering downtown along Pearl Street from the west were pedestrian trips. Only 70 percent of the trips along 13th Street from the south were made by walking.

Bicycle and Pedestrian Trip Generation

We found only one estimate of bicycle usage for a proposed facility—the trail between Providence and Bristol, Rhode Island (Brownell, 1982). Trips were modeled as a function of the employment, school enrollment, and population in zones within the trail's area of influence. Davis, et al. (1987) developed equations to predict 1–4 hour pedestrian counts using 5-, 10-, 15-, and 30-minute counts. For downtown Chicago, Soot (1990) estimated 10-hour pedestrian volumes by counting pedestrians for 1-hour and converting to a 10-hour total based on each site's daily pedestrian count pattern as observed 8 years later.

Concluding Remarks

The counts in a number of cities suggest that bicycle lanes and bicycle paths can realize volumes of 1,000 – 2,000 per day, at least when weather conditions permit. While other cities may use these figures as a crude estimate of bicycle travel, they must be aware that counts obtained in one city may not generalize to other cities because of the conditions and limitations under which the counts were made. The same caveat holds for pedestrian trips. Very busy downtown streets in large cities such as New York and Chicago may have 10,000 or more pedestrians per hour.

Multi-use trails often attract 500 or so pedestrians and several thousand bicyclists per day. Counts made at only one location along a trail will miss many users who bike or walk along other sections of trails. By contrast, counts made at multiple locations along a trail will double-count users. Perhaps bicycle/pedestrian offices should pick one or more key locations along a trail or on-street facility and report counts specific to those locations.

We did not find any studies that related bicyclist and pedestrian trip generation to a comprehensive range of land uses. If a local modal split is known or can be estimated, then that mode share can be applied to trip generation rates given in the ITE's manual to estimate the number of bicycle and pedestrian trips that a particular land use would generate. Thus, if a new trail were being proposed, the trips generated can be estimated according to the existing building types and floor space. Sometime after the trail is in place, the estimates should be compared with actual counts, to evaluate and refine this "modal split" approach and other methodologies that rely upon equations.

Pedestrians and bicyclists along selected routes may be surveyed to find out whether they would switch to a proposed facility. The users of a new facility can be asked whether they would have biked or walked in the first place, had the facility not been built.

Ideally, it would be possible to estimate trips directly from some combination of building type, floor space, population, bicycle ownership rates, type of facility, and other factors. To achieve this ideal, a national or large-scale database would be needed to provide the data for deriving equations that can be used to estimate trips.

The National Bicycling and Walking Study (1993) discusses the benefits associated with increased levels of bicycling and walking. In turn, surveys show that more people would bike and walk if there were more safe, attractive, convenient, and well-maintained facilities—sidewalks, trails, bike lockers, etc. In this era of constrained budgets, officials at all levels of government must choose among many competing uses for scarce resources. An estimate or idea of how many bicyclists and pedestrians are likely to use a proposed facility gives an indication of its benefits, and thus, whether it is worth the investment. From another perspective, transportation planners would have a sense for the role of bicycling and walking in the overall transportation scene. Thus, state and local pedestrian/bicyclist coordinators and others are urged to count systematically the number of users before and after a facility is built, as well as at comparison sites where no facility is built. A bicycle data collection form for movements through intersections and a bicycle facility survey form were developed during the project and are shown in Appendix A.

Traditionally, planners and other officials have given little, if any, consideration to nonmotorized modes of transportation. Given the requirements of ISTEA and the Clean Air Act Amendments, bicycling and walking are becoming key components of the American transportation system.

Table 8-1. Summary of bicycle counts.

	Method	Type of Facility	Time Period	Range of Counts	Year	Comments	Reference
Boston, MA	Manual count	Urban intersections	Thu 10/9/75 (Peak Hours) Thu 10/9/80	74-285/ pm peak hour 80-429/pm peak hour	1975 1980		Buckley (1982)
	Manual count	Urban intersections	Wed 5/13/81: 7 am - 7 pm	1,110-1,317/day	1981		Buckley (1982)
	Manual count	Urban intersections	Tues 10/16/90: 4 pm - 6:30 pm	55-368/peak hour	1990		Buckley (1991) memo
Providence, RI	Manual count	Bicycle path	Weekdays 5pm - 7 pm Weekends 9 am - 11 am	Estimated from counts 225-475/day	1991	1990: 80% bicyclists, 20% pedestrians	RI DOT (1991)
Davis, CA	Manual count	On-street bicycle lane	Weekdays 7:30 am - 8:30 am 3:30 pm - 5:30 pm	255/ 3 hours before 477/ 3 hours after	1974		Lott, et al. (1978) Personal correspondence, CALTRANS
	Manual count	Urban intersections	Wed 10/19/88	2,000 - 4,000/hour	1988	53% of students use bicycle as primary mode	Burden (1994)
	Survey			9,000 - 11,000/hour			Wilbur Smith Associates
Chula Vista, CA	Manual count	Urban intersections	6-9 am; 3-6 pm; 6-9 and 3-6; 6 am - 6 pm	8-49/hour 11-70/peak hour	1980		Bicycle Route Facilities Report (1981)
Chico, CA		Urban intersections Class I bikeway Class III bikeway	Nov. 1988: 7:30 am - 9:00 am 11:30 am - 12:45 pm 2:15 pm - 3:45 pm	454-808 /4 h 15 min 627 /4 h 15 min 555 /4 h 15 min	1988		Personal correspondence, CALTRANS
San Diego, CA	Manual	Urban streets	M-Th, Sep-Nov: 6-9 am and 3-6 pm	4-175/peak hour 12-712/ 6 hours	1990		San Diego Association of Governments (1991)
Eugene, OR		Bicycle path	Summer weekday Summer weekend	1,100/day 2,000/day	1978		Bikeways Oregon (1981)
		Bicycle lanes	Weekday	100-3,000/day	1978		Bikeways Oregon (1981)
	Permanent counter	Bicycle path		100-400/day	1974-1977		Regional Consultants (1977)
	Survey	Bicycle paths	Tue, Thu, Sat: 2,6, or 10.5 hrs		1977,1978	30-40% are work trips	Lipton (1979)
	Machine counters	Bicycle routes	5/21-5/27 at 2 locations 9/26-10/2	< 200 - > 1,400/day	1978		Regional Consultants (1979)
	Mechanical counters	Bicycle lane & path	One week, 12 N to 11 pm	450/day lane 567/day path			Personal Correspondence, Bishop

Table 8-1. Summary of bicycle counts. (con't)

	Method	Type of Facility	Time Period	Range of Counts	Year	Comments	Reference
Portland, OR	Manual count	Bicycle path	One day each in July, Aug, Sept: 14 hours/day	24-289/day	1989		State of Oregon Bikeway Program Group (1991)
	Questionnaire	Bicycle path	Two days in August: 10 hours/day	932/ 3 days	1993		Ronkin (1993)
New York, NY	Manual count	Urban streets	May: 0.5 - 1 hour per location	720/5.75 hours over 9 locations	1992		Transportation Alternatives (1992)
	Manual count	Urban streets Class I bicycle path	Summer weekday 7 am - 7 pm	113 - 1,069/day 602 - 1,183/day	1991 1991		NYCDOT (1992) NYCDOT (1992)
	Manual count	Class III bicycle lane		673-1,186/ day	1991		NYCDOT (1992)
Madison, WI	Automatic counter	Bike paths	Weekday, 24 hours	41/day 1/91 - 1,243/day 6/92	1988-1992		City of Madison DOT
	Loop detector	Urban intersection	December, 24 hours	2,309/day (weekday) 1,193/day (Sat), 647/day (Sun)	1993		City of Madison DOT
		Urban street		1,148/day (1/93) - 6,594/day (9/92)	1991-1994		City of Madison DOT
Phoenix, AZ	Manual count	Temporary bike lanes	Wed, 2/28/90: 7-9 am, 11-1 pm, 4-6 pm	560/ 6 hours	1990	Bike to Work Day Survey: 80% are work trips	Heffernan & Associates (1990)
	Manual count	Bike lanes at intersections	Weekdays, Nov & Dec.: 7-9 am, 11-1 pm, 3-6 pm	29-90/ 7 hours	1991	16% mode share for work trips	Cynecki, Perry & Frangos (1993)
	Manual count	Bike lanes at intersections	2/24 - 2/28: 7-9 am, 3-6 pm	30-100/ 5 hours	1992	Bike to Work Week	Cynecki, Perry, & Frangos (1993)
Denver, CO		Bike paths	August-October 1992 Weekdays, 6-9 a.m.	80-183/3 hours	1992		Personal Correspondence, Shedd
		Bike lane Wide curb lane Urban street		82/3 hours 74/3 hours 23-55/3 hours			
Seattle, WA	Urban intersections,	Bike paths, ferry terminal	September: one day, 6:30 - 9 am	Up to 152/ 2.5 hours	1992	Up to 11.5% mode share	Goldsmith (1992-1993)
		Ferry	One year	159,155/year	1993		Washington State Ferries
		Van carrying bicyclists & peds across drawbridge		678/month (12/90) - 5,532/month (7/91)	1989-1991		Personal Correspondence, Goldsmith

Table 8-1. Summary of bicycle counts. (con't)

	Method	Type of Facility	Time Period	Range of Counts	Year	Comments	Reference
Gainesville, FL	Manual count	Urban intersections connected to bike lanes, wide curb lanes, sidewalks	7 am - 7 pm	70-2,594/day	1993		North Central Florida Regional Planning Council (1994)
Fort Myers/ Lee County, FL	Soft rubber tubes Automated traffic counters	Bike path Bike lane Paved shoulder Sidewalk	May-October, unspecified hours	87/day avg. 37/day avg 33/day avg 63/day avg	1991		Personal correspondence, Salehi
Ft. Lauderdale, FL	Videotape	Urban streets with bike lane	Sat, 2/15/92 before Sat, 5/2/92 after	7-34/ 15 min 5-22/ 15 min	1992		Personal correspondence, Caicedo
Monroe County, FL		Urban streets Paved shoulder Bike paths	April 1994: Weekday (7hours) Saturday (6 hours) Sunday (6 hours)	211-681/day 14-151/day 50-736/day	1994		Personal correspondence, Henderson
Chapel Hill, NC	Videotape	Urban street with bike path	October 7 am - 7 pm	591/ day	1993		Personal correspondence, Bonk
Netherlands	Custom-designed sensors	Bike paths Bike path on tour route	3 hr period with a rush hour	1,199 - 1,693/3 hours 8,860/3 hours			Botma & Papendrecht (1991)

Table 8-2. Summary of multi-use trail counts.

Trail	Location	Method	Time Period	No. of Users	Percent Bicyclists	Percent Pedestrians	Percent Male	Reference
Pinellas	Clearwater-Largo St. Petersburg, FL	Survey	11/9/93 6:30 am - 6:00 pm	967 total				Pinellas Co. Dept. of Planning, personal correspondence
		Manual count	weekday	2,000 - 3,000 users 33% use trail to go to work, school, shopping			63%	
Burke-Gilman	Seattle, WA	Manual count and survey	Sat 5/19/90 & Tues 5/22/90: 7 am - 7 pm	Bicyclists: 13,204 (Sat) 4,225 (Tue) Pedestrians: 2,520 (Sat) 1,923 (Tue)			61% (Sat) 64% (Tue)	Personal correspondence, Moritz
Mt. Vernon	Washington, DC		Aug. 1983: Sun - 11 hours	1,048 total	55%	45%		Denver Service Ctr (1990)
			Mon - 11 hours	788 total				
			1985	820 total (Memorial Bridge) 400 total (14th St. Bridge) (60-65% commuters)	50 78	45 20	80	Denver Service Ctr (1990)
			Monthly 1988-1989	Belle Haven 779 (1/88) - 43,674 (7/89) Daingerfield 927 (1/88) - 19,129 (10/89) (75-80% commuters)			80	Denver Service Ctr (1990)

REFERENCES

An Evaluation of the Adequacy of the State of Maryland Demonstration Bikeway Segment. U.S. Department of Commerce. National Technical Information Service. AW078-200-046. October 1978. Revised June 1979.

Appleyard, Donald, with Gerson, M. Sue, and Lintell, Mark. Liveable Urban Streets: Managing Auto Traffic in Neighborhoods. Report No. FHWA/SES-76-03, Federal Highway Administration, Washington, DC, January 1976.

Appleyard, Donald, with Gerson, M. Sue, and Lintell, Mark. Liveable Streets. University of California Press, Berkeley, CA, 1981.

Berchem, S.P. A Community Campaign That Increased Helmet Use Among Bicyclists. (Unpublished Thesis). Madison, WI. University of Wisconsin - Madison, 1986.

Bicycle Route Facilities Report: October 1981. Chula Vista, CA, revised September 1983.

Bikeways Oregon, Inc. Bicycles in Cities: The Eugene Experience, Vol. II, 1981.

Botma, Hein, and Papendrecht, Hans. "Traffic Operation of Bicycle Traffic," Transportation Research Record 1320, 1991, pp. 65-72.

Brownell, John E. Providence-Bristol Bicycle Facility Trip Estimates. Rhode Island Department of Transportation Planning Division, Providence, RI, August 1982.

Buckley, Cathy A. "Bicycle Traffic Volumes," Transportation Research Record 847, 1982, pp. 93-102.

Buckley, Cathy A. (Central Transportation Planning Staff). Memorandum regarding bicycle traffic volumes in 1975, 1980, 1985, and 1990, February 21, 1991.

Burden, D., Wallwork, M., and Guttenplan, M. Bicycle and Motor Vehicle Roundabouts— A New Safety Tool to Aid Bicyclists, Pedestrians, Motorists and Transit in China and Other Locations. Presented at a conference entitled "Bicycle Safety, Planning and Design for Chinese Cities." Beijing, China: Beijing Research Institute for Traffic Engineers, April 1994.

Calthorpe Associates. TOD Impacts on Travel Behavior. 1992.

Comsis Corporation and the Institute of Transportation Engineers. Implementing Effective Travel Demand Management Measures: Inventory of Measures and Synthesis of Experience. Report No. DOT-T-94-02, U.S. Department of Transportation, Washington, D.C., September 1993.

Cynecki, Michael J., Perry, Grace, and Frangos, George. "A Study of Bicyclist Characteristics in Phoenix, Arizona." Transportation Research Record 1405, 1993.

Dane County Regional Planning Commission and Madison Department of Transportation. (In cooperation with the Pedestrian/Bicyclist Subcommittee of the Madison Transportation Commission.) A Bicycle Plan for the City of Madison and Dane County, Wisconsin. Madison, WI. Author, 1991.

Dane County Regional Planning Commission and Madison Department of Transportation. A Bicycle Transportation Plan for Madison, Wisconsin, and Dane County, Wisconsin. Madison, WI. December 1990.

Davis, Scott E., King, L. Ellis, Robertson, H.D., Mingo, Roger, and Washington, Joel R. Measuring Pedestrian Volumes and Conflicts, Volume I—Pedestrian Volume Sampling. Report No. FHWA/RD-088/036. Analysis Group, Incorporated, Washington, DC, December 1987.

Denver Service Center (Eastern Team). "Paved Recreation Trails of the National Capital Region: Recommendations for Improvements and Coordination to Form a Metropolitan Multi-Use Trail System." Washington, DC, June 1990.

Department of Conservation. Bureau of Parks and Recreation. Maine 1992 Household Survey Results. (Draft). Augusta, ME. Author, November 1992.

Florida Department of Transportation. State Road A-1-A Bicycle Lane Study. Fort Lauderdale, FL: Author, December, 1993.

Frank, Lawrence. "The Impacts of Mixed Use and Density on the Utilization of Three Modes of Travel: The Single Occupant Vehicle, Transit, and Walking." Presented at the Transportation Research Board 73rd annual meeting, January 9-13, 1994, Washington, DC.

Goldsmith, S. Expanding Seattle's Urban Trails System into the Central Business District: Plan to Save Energy, Reduce Traffic Congestion, and Improve Air Quality. (Draft Final Report for the Urban Consortium Energy Task Force). Seattle, WA: City of Seattle Engineering Department, Transportation Services Division, Bicycle and Pedestrian Program, 1992–1993.

Goldsmith, Stewart A. Reasons Why Bicycling and Walking Are and Are Not Being Used More Extensively as Travel Modes. Case Study No. 1 for the National Bicycling and Walking Study, Report No. FHWA-PD-92-041. Prepared for the Federal Highway Administration, Washington, DC, 1992.

Greenways Incorporated, Transportation Potential and Other Benefits of Off-Road Bicycle and Pedestrian Facilities. Case Study No. 7 for the National Bicycling and Walking Study, Report No. FHWA-PD-92-040. Prepared for the Federal Highway Administration, Washington, DC, 1992.

Heffernan and Associates, Evaluation Study: Bike-to-Work Day, February 28, 1990. Prepared for the City of Phoenix, April 1990.

Herman, M., Komahoff, C., Orcutt, J., and Perry, D. Bicycle Blueprint—A Plan to Bring Bicycling into the Mainstream in New York City. New York. Transportation Alternatives, 1993.

Holtzclaw, John. Explaining Urban Density and Transit Impacts on Auto Use. Presented to the State of California Energy Resources Conservation and Development Commission, January 1991.

Hu, P.S. Preliminary Results of the 1990 Nationwide Personal Transportation Survey. Oak Ridge National Laboratory, Oak Ridge, TN, 1991.

Institute of Transportation Engineers. Trip Generation Manual. 5th edition. Washington, DC. 1991.

Kagan, L.S., Scott, W.G., and Avin, U.P. A Pedestrian Planning Procedures Manual. Volumes I-III. Report Nos. FHWA-RD-79-45, -79-46, -79-47. Federal Highway Administration, Washington, DC, November 1978.

Kulash, Walter. "Traditional Neighborhood Development: Will the Traffic Work?" Prepared for the American Society of Civil Engineers, Successful Land Development: Quality and Profits Conference, March 1990.

Lennard, Suzanne H. Crowhurst, and Lennard, Henry L. Livable Cities. Gondolier Press, Southampton, NY, 1987.

Levelt, P.B.M. New Pedestrian Facilities: Technique, Observations, and Opinions - The Dutch Experiment. SWOV Institute for Road Safety Research, Leidschendam, Netherlands, 1992.

Lipton, S. Gregory. "Evaluation of the Eugene, Oregon, Greenway Bicycle Bridge," Transportation Research Record 739, 1979, pp. 29–37.

Lott, Dale, F., Tardiff, Timothy, and Lott, Donna Y. "Evaluation by Experienced Riders of a New Bicycle Lane in an Established Bikeway System," Transportation Research Record 683, 1979, pp. 40–46.

Miller, M.A., and Miller, T.I. Modal Shift in the Boulder Valley 1990 to 1992. Boulder, CO. Center for Policy and Program Analysis. Office of the City Manager, May 1993.

Miller, M.A., and Miller, T.I. The 1990 Diary Study of Modal Split in Boulder Valley. Boulder, CO. Division of Research and Evaluation. Department of Community Planning and Development. February 1991.

Miller, M.A., and Miller, T.I. The 1990-1991 Corridor Count Report. Boulder, CO. Division of Research and Evaluation. Department of Community Planning and Development. March 1991.

Miller, M.A., and Miller, T.I. The 1991 Boulder Valley Employee Survey. Boulder, CO. Division of Research and Evaluation. Office of the City Manager. March 1992.

Miller, M.A., and Miller, T.I. 1993 Downtown Employee Survey. Boulder, CO. Center for Policy and Program Analysis. Office of the City Manager, December, 1993.

Moore, R.L., Graefe, A.R., Gitelson, R.J., and Porter, E. The Impacts of Rail-Trails: A Study of the Users and Property Owners from Three Trails. Washington, D.C., Rivers, Trails, and Conservation Assistance Program. National Park Service. In cooperation with Leisure Studies Program, School of Hotel, Restaurant, and Recreation Management. The Pennsylvania State University. February 1992.

Moore, Roger L., Graefe, Alan R., Gitelson, Richard J., Porter, Elizabeth. The Impacts of Rail-Trails: A Study of the Users and Property Owners from Three Trails. U.S. Department of the Interior, Washington, DC, February 1992.

National Bicycle and Walking Study Interim Report. Report No. FHWA-PD-92-003, Federal Highway Administration, Washington, DC, November 1991.

New York City Department of Transportation. New York City Bicycle Statistics 1991. November 1992.

North Central Florida Regional Planning Council. 1993. Bicycle Usage Trends Program. Gainesville, FL. Author, 1994.

O'Neil Associates. Bicycle Riding Behavior & Attitudes Toward Bicycle Riding in Scottsdale. Study No. 88-431, Tempe, AZ, February 1988.

Parsons, Brinckerhoff Quade and Douglas, Inc. Cambridge Systematics, Inc., and Calthorpe Associates. The Pedestrians Environment. (Volume 4A—Making the Land Use Transportation Air Quality Connection). Portland, Oregon: 1000. Friends of Oregon. December, 1993.

Parsons, Brinckerhoff Quade and Douglas, Inc. Cambridge Systematics, Inc., and Calthorpe Associates. The Pedestrian Environment.

Peers, Jack. Effect of Stockton's Proposed Village Center Development on Travel Mode Choice and Auto Use. Fehr and Peers Associates, January 1992.

Peers, Jack, et al. The Effect of Neotraditional Neighborhood Design on Travel 'Characteristics. Fehr and Peers Associates, 1992.

Project for Public Spaces. The Effects of Environmental Design on the Amount and Type of Bicycling and Walking. Case Study No. 20 for the National Bicycling and Walking Study, Report No. FHWA-

PD-93-037. Prepared for the Federal Highway Administration, Washington, DC, April 1993.

Pushkarev, B.S., and Zupan, J.M. Public Transportation and Land Use Policy. Bloomington, Indiana. Indiana University Press, 1977.

Pushkarev, Boris, and Zupan, Jeffrey M. Urban Space for Pedestrians. MIT Press, Cambridge, MA, 1975.

Pushkarev, Boris, and Zupan, Jeffrey M. Public Transportation and Land Use Policy, 1977.

Regional Consultants, Inc. Evaluation of the Eugene Bikeways Master Plan. Prepared for the City of Eugene, Oregon, July 1979.

Rhode Island Department of Transportation. 1990 Estimated Bicycle Volumes—East Bay Bicycle Path. Providence, RI, May 1991.

Rodale Press. Pathways for People. Rodale Press, Emmaus, PA, 1992.

Ronkin, Michael (Bicycle/Pedestrian Program Manager, Oregon Department of Transportation). Memorandum to Larry Olson (Region I Support Services Manager, Oregon Department of Transportation) regarding I-205 bike path survey, December 7, 1993.

RTKL Associates, Inc. Trip Generation Data October 1976.

San Diego Association of Governments. Bicycle Counts at Selected Intersections in San Diego County 1990. San Diego, CA. Author, February 1991.

Seneviratne, P.N., and Morrall, J.F. "Level of Service on Pedestrian Facilities," Transportation Quarterly, Vol. 39, No. 1, January 1985, pp. 109–123.

Soot, Siim. "Trends in Downtown Pedestrian Traffic and Methods of Estimating Daily Volumes," Transportation Research Record 1325, 1991, pp. 75–82.

State of Oregon Bikeway Program Group. "Summary: 1986, 1987 & 1989 Bicycle Manual Counts." Correspondence from Frank Swant, NHTSA Region X, Seattle, WA, to Barbara Vuono, NHTSA, Washington, DC, May 9, 1991.

Takacs, Dan, and Mulinazzi, Thomas. An Evaluation of the State of Maryland Demonstration Bikeway Projects. Report No. FHWA-MD 78-12, prepared for the Maryland State Highway Administration, University of Maryland, College Park, MD, June 1979.

Tobey, H.N., Shunamen, E.M., and Knoblauch, R.L. Pedestrian Trip Making Characteristics and Exposure Measures. Report No. FHWA/RD-83/062, Federal Highway Administration, Washington, DC, October 1983.

Transportation Alternatives. "Bicycles Near 10% of Midtown Avenue Traffic." Release July 20, 1990.

Transportation Research Board. Highway Capacity Manual. Special Report 209, National Research Council, Washington, DC, 1985.

Untermann, Richard K. Accommodating the Pedestrian: Adapting Towns and Neighborhoods for Walking and Bicycling. Van Nostrand Reinhold Company, New York, 1984.

Wilbur Smith Associates. City of Davis Transportation Survey, 1991.

Wilkinson, W.C., Clarke, A., Epperson, B., and Knoblauch, R.L. Selecting Roadway Design Treatments to Accommodate Bicycles (FHWA-RD-92-073). Federal Highway Administration, Washington, DC, 1992.

APPENDIX A

EXAMPLE

Bicyclist Observation Form Page 1 of 1

Date: 11/19/93 Day: F Time: Start 12:40 Finish 1:40 Observer: WEP
Intersection/Location Cameron / Columbia Location # 3
Weather: Clear/Cloudy/Raining Temperature: 61
Light: Daylight/Dusk/Dawn/Darkness

Legend:
- <16/16+ - less than 16 years/16 or older
- y/n - yes helmet/no helmet
- w/a - with traffic/against traffic
- r/s - road/sidewalk (includes other off-street)
- blank box - bicyclist direction code

CIRCLE LOCATION; PLACE "X" AT OBSERVATION POINT

Draw other

INDICATE NORTH

# of thru lanes of largest leg 2

Circle female

			Entering		Exiting		
1	<16 16+	y n	w a	r s	w a	r s	AC
2	<16 16+	y n	w a	r s	w a	r s	AC
3	<16 16+	y n	w a	r s	w a	r s	DC ✓
4	<16 16+	y n	w a	r s	w a	r s	AD
5	<16 16+	y n	w a	r s	w a	r s	DC
6	<16 16+	y n	w a	r s	w a	r s	CB
7	<16 16+	y n	w a	r s	w a	r s	CB
8	<16 16+	y n	w a	r s	w a	r s	AD
9	<16 16+	y n	w a	r s	w a	r s	DA
10	<16 16+	y n	w a	r s	w a	r s	DA ✓
11	<16 16+	y n	w a	r s	w a	r s	
12	<16 16+	y n	w a	r s	w a	r s	
13	<16 16+	y n	w a	r s	w a	r s	
14	<16 16+	y n	w a	r s	w a	r s	
15	<16 16+	y n	w a	r s	w a	r s	
16	<16 16+	y n	w a	r s	w a	r s	
17	<16 16+	y n	w a	r s	w a	r s	
18	<16 16+	y n	w a	r s	w a	r s	
19	<16 16+	y n	w a	r s	w a	r s	
20	<16 16+	y n	w a	r s	w a	r s	
21	<16 16+	y n	w a	r s	w a	r s	
22	<16 16+	y n	w a	r s	w a	r s	
23	<16 16+	y n	w a	r s	w a	r s	
24	<16 16+	y n	w a	r s	w a	r s	
25	<16 16+	y n	w a	r s	w a	r s	
26	<16 16+	y n	w a	r s	w a	r s	
27	<16 16+	y n	w a	r s	w a	r s	
28	<16 16+	y n	w a	r s	w a	r s	
29	<16 16+	y n	w a	r s	w a	r s	
30	<16 16+	y n	w a	r s	w a	r s	

SUGGESTED OPTIONS:
- Circle left turns performed "like a pedestrian."
- ✓ if violated traffic control

Bicyclists observed 10

M	6	60 %	F	4	40 %
<16	1	10 %	16+	9	90 %
Yes helmet	2	20 %	No helmet	8	80 %
Entering: wr	6	60 %	ws	1	10 %
ar	-	- %	as	3	30 %
Exiting: wr	6	60 %	ws	-	- %
ar	-	- %	as	4	40 %

AB	AC 2	AD 2	AE
BD	BA	BC	BE
CA	CD	CB 2	CE
DC 2	DB	DA 2	DE
ED	EA	EC	EB

U of North Carolina, Highway Safety Research Center

Bicycle facilities/use questionnaire

Please place a "✔" or provide the information as appropriate. **Circle** any responses that are not supported with hard data but rather are your "best quesses." For **bicycle lanes**, complete a separate questionnaire for each segment of the bicycle lane on which count data is available.

Bicycle Facility (check as appropriate)

___ Bicycle lane
___ Paved shoulder — Bicycle Routes designation? ___ Yes ___ No
___ Wide lane — Bicycle Route designation: ___ Yes ___ No
___ Parallel multi-use path with bikeway designation — Specify: ___ Bicycle Route ___ Bicycle Path
___ Multi-use path (not within highway right-of-way)

A. Bicycle lane description

1. Street name or # ____________________________
2. Length of total bicycle lane: ____ miles (nearest .1 mile)
3. Total number of segments ____
4. Segment # ____(sequentially number segments starting from one end of the bicycle lane)
5. Length of bicycle lane segment: ____ miles (nearest .1 mile)
6. Bicycle lane width: ____feet ____inches (if curb & gutter, measure from gutter/road seam)
7. Lane stripe width: ____ inches
8. Number of pavement markings (e.g., bicycle, diamond, etc.) along segment length: ____
9. Number of bicycle lane signs along segment length: ____
10. Is the bicycle lane a part-time parking or refuge lane? ____Yes ____ No
    If yes, how many hours per day is the bicycle lane exclusively for bicyclists? ____hrs
11. Is there a physical barrier (e.g., curb) to separate from motor vehicle traffic? ____Yes ____No
12. Is there a sidewalk adjacent to the bicycle lane? ____Yes ____ No
    If yes, note in section H. how many bicyclists used the sidewalk if known.

B. Describe the conditions adjacent to the right of the bicycle lane segment. (check all that apply)

1.____ Paved shoulder
2.____ Unpaved shoulder
3.____ No shoulder
4.____ On-street parking
5.____ Curb and gutter
    Type: ___ ___ ___ ___ other
    Gutter width: ___ inches
6.____ Pavement goes to curb face
7.____ Other ____

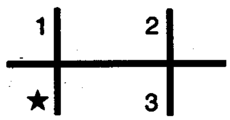
C. Street/Bicycle lane configuration (check one)

1. ___ One-way street with one-way bicycle lane
2. ___ One-way street with two-way bicycle lane
3. ___ Two-way street; one-way bicycle lane on one side
4. ___ Two-way street; two-way bicycle lane on one side
5. ___ Two-way street; one-way bicycle lane on both sides
6. ___ Other ______________________________

D. Bicycle lane connectivity

How many intersecting "bicycle friendly" facilities (e.g., other bicycle lanes, multi-use paths, paved shoulders, wide outside lanes, or local streets) connect to the bicycle lane segment?

Example: This particular bicycle lane segment (horizontal line) has 3 "bicycle friendly" connections.



(The "★" segment is a narrow high speed road that is not "bicycle friendly.")

___ 0
___ 1
___ 2
___ 3
___ 4
___ 5 or more

E. Bicycle lane project development

1. Why was a bicycle lane constructed on this road? (check all that apply)

___ high bicyclist use
___ potential bicyclist use (presence of major trip generators; scenic,etc.)
___ improve bicyclist safety
___ improve motor vehicle flow
___ improve pedestrian safety
___ other ______________________________

2. How was the bicycle lane segment achieved? (check all that apply)

___ wide outside lane striped for a bicycle lane
___ narrowing of motor vehicle lanes
___ parking removed
___ incidental part of new road construction
___ incidental part of overall road improvement/widening
___ independent project
___ other ______________________________
___ unknown

F. Paved shoulder

1. Street name or # ______________________________
2. Shoulder Width: _____ feet _____ inches

H. Parallel multi-use path with bikeway designation

1. Street name or # ______________________________
2. Path width: _____ feet _____ inches

I. Multi-use path

1. Length of entire path: _____ miles (nearest .1 mile)
2. Length of segment (between roadway intersections where count was made) : _____ miles; (nearest .1 mile)
3. Width: _____ feet (nearest 1/2 foot)

J. Roadway description

1. _____ local _____ collector _____ arterial
2. Number of through motor vehicle lanes (both directions combined):
3. Center turn lane: _____ Yes _____ No
4. Left turn lane: _____ Yes _____ No
5. Right turn lane: _____ Yes _____ No
6. Adjacent MV lane width: _____ feet
7. _____ Total number of roadway intersections on segment.

K. Motor vehicle traffic description

1. Posted speed limit (mph): ____ 25 or less; ____ 30-35; ____ 40-45; ____ 50-55; ____ 60-65
2. ADT: ____ <2500; ____ 2501-7500; ____ 7501-12,500; ____ 12,501-20,000; ____ >20,000
3. Truck Route? ____ Yes ____ No
4. % trucks/buses/RV: ____ <5%; ____ 5-10%; ____ >10%

L. Location description

1. ____ Rural ____ Suburban ____ Urban
2. Population: ______________________________
3. Area: _____ square miles
4. Bicycle facility service to major trip generators (check all that apply; place number for more than one.
   - ____ college; high school; vocational school
   - ____ elementary/middle school
   - ____ recreational
   - ____ shopping center
   - ____ Central Business District
   - ____ housing/apt. complex
   - ____ residential neighborhood
   - ____ professional/office complex
   - ____ transit center
   - ____ other ______________________________

M. Bicyclist count data

1. If available, please provide bicyclist count data collected prior to construction of the bicycle facility. Briefly describe count methodology. Attach documentation or additional information if available.

____

____

____

____

____

____

2. Please provide bicyclist count data collected after construction of the bicycle facility. Briefly describe count methodology. Attach documentation or additional information if available.

____

____

____

____

____

____

N. Additional bicyclist count information

Please provide any other count information or facilities information you may have. This could include such things as percent modal share of bicyclists, total number of bicyclists in the community, total miles of bicycle lanes and multi-use paths, etc.

____

____

____

____

____

____

O. Bicycle facility user characteristics

1. Please estimate the percentage of users that each group compromises.
   Child (<16 yrs) _____ %
   Adult (≥16 yrs) _____ %
   Total 100%

2. For a novice adult bicyclist, how easy (how accessible) is it to ride a bicycle from the nearest residential area to the bicycle facility?
   _____ easily accessible _____ moderately accessible _____ diffucult to access

3. If more bicyclists are using the roadway corridor after the bicycle facility improvement than did previously, please estimate what percentage are:
   _____ new bicyclists (latent demand released)
   _____ existing bicyclists drawn off of other routes
   100%

P. Bicycle-friendly checklist (check all that apply in your community).

_____ bicycle advocacy group or advisory committee
_____ bicycle coordinator or contact person in local government
_____ bicycle master plan
_____ bicycle element in transportation, comprehensive, and other appropriate plans
_____ bicycle related projects in the TIP and CIP
_____ bicycle parking requirements in zoning laws
_____ police bicycle patrol
_____ bicycle promotion/safety events
_____ bicycle routes and suitability map
_____ bicycle training in schools
_____ other ____

Q. Additional comments ____
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____
____
____
____

Recycled
Recyclable

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